PB82-105479

Pilot Field Studies of FGD Waste Disposal at Louisville Gas and Electric

Louisville Gas and Electric Co., KY

Prepared for

Industrial Environmental Research Lab.
Research Triangle Park, NC

1981

U.S. Department of Commerce
National Technical Information Service
NTIS

PB82-105479

EPA-600/7-81-155

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FINAL REPORT

PILOT FIELD STUDIES OF FGD WASTE DISPOSAL AT LOUISVILLE GAS & ELECTRIC

BY

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Contract No. 68-02-2143

EPA Project Officer: Julian W. Jones

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SYSTEMS
COMBUSTION ENGINEERING, INC.

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IERL-RTP-1252

TECHNICAL REPORT DATA
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1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO. PB82 105479
4. TITLE AND SUBTITLE Pilot Field Studies of FGD Waste Disposal at Louisville Gas and Electric		5. REPORT DATE
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) R. P. Van Ness (LGE), A. L. Plumley and N. C. Mohn (Combustion Engineering, Inc.), and C. R. Ullrich and D. J. Hagerty (Univ. of Louisville)		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Louisville Gas and Electric Company 311 West Chestnut Street Louisville, Kentucky 40232		10. PROGRAM ELEMENT NO.
		11. CONTRACT/GRANT NO. 68-02-2143
12. SPONSORING AGENCY NAME AND ADDRESS EPA, Office of Research and Development Industrial Environmental Research Laboratory Research Triangle Park, NC 27711		13. TYPE OF REPORT AND PERIOD COVERED Final; 5/76-8/79
		14. SPONSORING AGENCY CODE EPA/600/13

15. SUPPLEMENTARY NOTES IERL-RTP project officer is Julian W. Jones, Mail Drop 61, 919/541-7606.

16. ABSTRACT The report gives results of pilot field studies of flue gas desulfurization (FGD) waste disposal at Louisville Gas and Electric Co. The studies showed that properly prepared landfill from FGD sludge/fly ash mixtures can prevent trace element contamination of underlying groundwater. Analyses of leachates from the landfill impoundments studied showed that trace elements on the RCRA list of contaminants were found in concentrations below those proposed to characterize hazardous or toxic wastes. Decreasing concentrations, with time, of trace contaminants were observed in both leachate and runoff samples from the stabilized sludge mixtures. Small, synthetically lined, above-ground impoundments had higher concentrations of trace contaminants than subsurface impoundments since no attenuation by local soil was provided and vegetation that might minimize runoff was not established on these sites. Most sites developed compressive strengths significantly greater than the minimum required for recreational or light structural landfill. Water samples from beneath larger subsurface impoundments indicated that the filtering action of soil aids in decreasing the concentration of contaminants reaching the ground water supply. Certain mixtures have undergone a fixation reaction, reducing the permeability and minimizing the release of moisture and/or contaminants to the surrounding soil.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group	
Pollution	Fly Ash	Pollution Control	13B	
Waste Disposal	Groundwater	Stationary Sources		08H
Flue Gases	Leaching		21B	
Desulfurization	Toxicity		07A,07D	06T
Earth Fills			13C	
Sludge				

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18. DISTRIBUTION STATEMENT Release to Public	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 311
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE

EPA Form 2220-1 (9-73)

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IERL-RTP-1252

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Prepared For

U. S. ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development
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ABSTRACT

Properly prepared landfill from FGD sludge/fly ash mixtures can prevent trace element contamination of underlying groundwater. Analyses of leachates from the series of landfill impoundments in this study show that trace elements on the RCRA list of contaminants were found in concentrations below those proposed to characterize hazardous or toxic wastes.

A trend toward decreasing concentrations, with time, of trace contaminants was observed in both leachate and runoff samples obtained from the stabilized sludge mixtures. Small, synthetically lined, above ground impoundments provided higher concentrations of trace contaminants than the subsurface impoundments since no attenuation by local soil was provided and vegetation that might minimize runoff was not established on these sites.

Most sites developed compressive strengths significantly greater than the minimum required for recreational or light structural landfill. Water samples obtained from beneath larger subsurface impoundments indicated that the filtering action of soil aids in decreasing the concentration of contaminants reaching the ground water supply. Certain mixtures have undergone a fixation reaction, reducing the permeability and minimizing the release of moisture and/or contaminants to the surrounding soil.

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SECTION 1

INTRODUCTION

The most extensive commercial experience in flue gas desulfurization (FGD) has to date been with lime/limestone wet-scrubbers. It is anticipated that these systems will account for the majority of sulfur or SO_2 removal at electric power stations for the next 10 to 15 years. One of the major challenges associated with the commercial development of these systems is the disposal of large amounts of by-product sludge within the constraints of land and water-quality regulations. It has been estimated that by 1985, air quality control regulations will require the desulfurization of flue gas from 60 million KW of electric generating capacity per year. If this estimate is realized, over 27.2M grams (30 million tons) of ash-free by-product sludge (50% solids) will be produced per year.(1)

Over the past eleven years, more than fifty different procedures for direct disposal or process utilization of this sludge have been evaluated.(2,3) Most investigators have concluded that utilization will not be able to provide viable alternatives to proper disposal of the sludge any more than utilization of fly ash (10 to 15 percent of annual production) has solved the problem of fly ash disposal. Consequently, most of the waste by-products from flue gas desulfurization will be disposed of in ponds or used as landfill. The choice of disposal methods and amount of treatment required will depend on the geographical location, legal and environmental requirements, economic considerations, and the particular preferences of the operating company.

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Prior laboratory work has indicated the environmental advantages of the disposal of stabilized FGD by-product sludges over untreated FGD sludges. Haas and Ladd(4) showed that waste solids from a limestone scrubbing system could be stabilized by dewatering and subsequent mixing with clay soil or a western type flyash having a high alkali content. Further studies(5,6) showed that the addition of fly ash and/or lime to FGD sludge solids resulted in the formation of a number of mineral compounds of high strength and low permeability.

These initial studies focused primarily on treatment of FGD sludges to enhance structural properties. However, in addition to being physically unstable, FGD sludges contain varying concentrations of trace elements and dissolved salts which have the potential to contaminate surface and groundwater. Although some soils will absorb many of the trace elements in FGD sludge, major ions, such as calcium, sulfate and chloride may not be readily absorbed. Therefore, the disposal of sludge must also address procedures to minimize runoff and to control or prevent seepage. Consequently, leachate analyses were added to the unconfined compressive strength and permeability tests that were already a part of sludge-landfill stabilization studies.

The work described in this report is a major laboratory/field demonstration of landfill disposal of FGD by-product sludges by Louisville Gas and Electric with Combustion Engineering, Inc. and the University of Louisville, performed under contract with the Industrial Environmental Research Laboratory of EPA at Research Triangle Park, North Carolina.

This project was designed to demonstrate the feasibility of landfill disposal of by-product FGD sludge treated with various mixtures of flyash and stabilizing additives.

Prior to the start of this demonstration, two criteria were established to define an acceptable landfill material. (1) A landfill material must have sufficient structural integrity to meet minimum standards of: compressive strength >0.1 MPa (1 ton/ft^2) and permeability $<5 \times 10^{-5}$ cm/s.(7) (2) In addition, a landfill material must not contaminate groundwater by leachate or surface water by runoff or erosion. The standards used for leachate evaluation were the levels which had been proposed for defining leachates from hazardous wastes under the Resource Conservation and Recovery Act, section 261.24(8) and the U.S. Public Health Service Drinking Water Standards. Both of these standards are shown in Table 1.

TABLE 1. CRITERIA FOR EVALUATION OF LEACHATE ENVIRONMENTAL IMPACT

	U. S. Public Health Service Drinking Water Standards		
Characteristics	Suggested Limit That Should Not Be Exceeded	Cause For Rejection	Proposed Toxicity Criteria For Hazardous Waste Under RCRA
Physical			
Color	15 Units		
Taste	Unobjectionable		
Threshold odor number	3		
Turbidity	5 Units		
Chemical	mg/l	mg/l	mg/l
Alkyl benzene sulfonate	0.5		
Arsenic	0.01	0.05	5.0
Barium		1.0	100
Cadmium		0.01	1.0
Chloride	250		
Chromium (hexavalent)		0.05	5.0
Copper	1		
Carbon chloroform extract (a)	0.2		
Cyanide	0.01	0.2	
Fluoride (b)	0.7-1.2	1.4-2.4	
Iron	0.3		
Lead		0.05	5.0
Nitrate	45		
Phenols	0.001		
Selenium		0.01	1.0
Silver		0.05	5.0
Sulfate	250		
Zinc	5		
Mercury			0.2
Total Dissolved Solids	500		

a -Organic contaminants.

b -The concentration of fluoride may be between 0.6 and 1.7 mg/l, depending on the listed annual average maximum daily air temperature.

SECTION 2

PROJECT OBJECTIVES

This project was designed to demonstrate the feasibility of environmentally acceptable landfill disposal of mixtures of FGD by-product sludge and fly ash.

The project was part of an overall program which covered scrubber testing as well as waste disposal at Paddy's Run Station of Louisville Gas & Electric.

The FGD by-products used in this demonstration were obtained from the wet scrubbing of flue gas from combustion of 3% sulfur West Kentucky coal at the 65 Mw station generator (No. 6) at the Paddy's Run Station, Louisville, Kentucky. Fly ash was obtained from the electrostatic precipitator hoppers of the No. 6 steam generator during the test period.

The waste disposal project consisted of two separate phases each using a different type of absorbent to remove SO_2 from the flue gas during the scrubbing operation.

Since the FGD system at Paddy's Run was placed in operation in 1973, carbide lime, a locally available by-product from acetylene manufacture, consisting primarily of $Ca(OH)_2$, has been used as the absorbent. Phase I of the waste disposal project was designed to provide a demonstration of impoundment of mixtures of flyash and chemically treated sludge from carbide lime scrubbing.

From the standpoint of general usage, commercial lime is more likely to be utilized as the SO_2 absorbent. Phase II of this project was conducted, therefore, using sludge obtained from scrubber operation with commercial lime absorbent.

SECTION 3

CONCLUSIONS

1. FGD waste sludges can be stabilized to give compressive strengths greater than the minimum required for acceptable landfill disposal. In this study, stabilized sludge samples developed compressive strengths ranging from 0.29 to 2.39 MPa (3.0 to 25 tons/ft^2) when cured and tested under controlled laboratory conditions. Subsequent field testing of selected stabilized sludge mixtures showed strengths from 0.01 to 0.50 Mpa (0.13 to 5.4 tons/ft^2), measured on core samples removed from the field sites and tested in the laboratory.

2. The correlation between strengths measured on laboratory samples and on core samples from field testing of a particular sludge was poor. It was felt this was due primarily to the unavoidable disturbance of the core samples during collection. The use of a concentric drill/Shelby tubes (Dennison sampler) should prove more satisfactory for this application. In-situ plate load tests on several field sites showed strengths developed in stabilized sludges which were significantly higher than indicated by core sample measurements.

3. Stabilization reduces the permeability of sludges, thus minimizing leachate generation. In this study, both laboratory samples and core samples from field test sites showed an inverse relationship between strength and permeability.

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4. Properly prepared landfill from FGD sludge/fly ash mixtures can prevent trace element contamination of the underlying groundwater. All leachates collected from stabilized sludges in this study contained trace elements in concentrations below those proposed to define a hazardous waste under RCRA. (Table 1)

5. Process II mixtures which contained rotary drum vacuum filter cake, fly ash and fixative provided the optimum combination of compressive strength and permeability for landfilling both carbide lime and commercial lime sludges. Process I, utilizing thickener underflow, provided a mixture which had low bearing capacity and relatively high permeability and Process III, which compounded mixtures with filter press high solids cake, proved too brittle. Both I and III mixtures gained little compressive strength with time and thus are considered unacceptable as landfill.

SECTION 4

PROJECT DESCRIPTION

The project was divided into two phases: laboratory testing and field demonstration. The laboratory tests provided baseline values for the strength, permeability, and leachate quality of each mixture evaluated. The field demonstration was designed to provide similar information on the behavior of stabilized materials under natural environmental conditions including precipitation, and freeze/thaw. Included in the field phase was evaluation of the handling, transportation, and placement of the various sludge mixtures.

In this project, the stabilization of sludge from three dewatering processes was evaluated in the laboratory and under field conditions. Process I involving mixing fly ash and a fixative (stabilizing additive) with thickener underflow to form a pumpable mixture that was designed to be self-hardening upon standing. Process II consisted of mixing fly ash, partially dewatered sludge, and a fixative to form a compactable stable landfill. Process III used a maximum dewatered sludge, fixative, and/or fly ash to form a compactable, stable landfill.

The laboratory tests screened a large number of stabilized sludge/fly ash mixtures for consideration in the field demonstration phase. The sludges were mixed with fly ash in ratios ranging from 0:1 to 1.5:1 parts by weight fly ash to dry scrubber solids. Varying percentages of fixative (lime, hydrated lime, carbide lime, or Portland cement) were added to determine the quantity necessary to achieve optimum results.

To predict the landfill behavior of stabilized sludges, the following series of tests were performed:

1. Unconfined compressive strength
2. Permeability
3. Leachate analysis

The results of the laboratory testing are discussed in depth in Section 5. Briefly, on the basis of the laboratory test results, ten mixtures were chosen for field evaluation. The mixtures were chosen to allow comparison between sludges with different degrees of dewatering and/or fixation additives.(9)

A quantity of each of the selected mixtures was prepared in the field with a process train designed for this purpose. The sludge/fly ash/treated mixtures were impounded in specially prepared sites designed to facilitate collection of leachate. A series of ten commercial above-ground swimming pools and five larger subsurface impoundments were used as monitored disposal sites for the mixtures.(9,10)

SECTION 5

LABORATORY TESTING

The laboratory testing phase served as a screening effort in which a large number of stabilized sludge mixtures could be evaluated. The lab data provided the basis for the selection of a smaller group of mixtures for further field evaluation.

Sixty (60) mixtures were prepared for the initial laboratory screening. Sludges from two FGD scrubbing processes were used in this study. One sludge was generated at LG&E's Paddy's Run Unit No.6 using carbide lime as the scrubber absorbent. This carbide lime sludge contains mainly calcium sulfite (Table 2). Less than 10% of the sulfur products are oxidized to calcium sulfate. Because of the high sulfite content, the carbide lime sludge is very difficult to dewater. Previous field observations had indicated that the thickener underflows contained 18 to 24% solids and the vacuum filter cake contained 35 to 42% solids. Tests at vendor laboratories had shown that 50 to 55% solids could be obtained with a filter press operating at 1035 KPa, (150 psig). The other sludge evaluated in the laboratory program resulted from the operation of Combustion Engineering's 12.340 Nm^3/hr (12,000 SCFM) Prototype Scrubber using commercial lime as the scrubber absorbent. The commercial lime sludge contains a greater amount of calcium sulfate, with 10 to 20% of the sulfur products oxidized to the sulfate form (Table 2). As a result, the material dewatered considerably better than the carbide lime sludge. Thickener underflow was expected to contain 26 to 30% solids while field vacuum filtration had been shown to dewater the material to 50% solids. Laboratory studies indicated that 65% solids could be obtained by using a filter press to dewater commercial lime sludge.

TABLE 2. CARBIDE & COMMERCIAL LIME-TYPICAL ANALYSIS
(given in % by weight unless noted otherwise)

Analysis	Commercial Lime Sludge		Carbide Lime Sludge	Fly Ash
	As Rec'd	Mg Added		
CaO	40.53	38.07	30.10	1.71
SO_2 (b)	8.63	5.26	5.43	0.78 (a)
SO_3 (c)	36.42	39.20	38.13	--
MgO	0.17	1.87	0.19	0.56
Al_2O_3	0.87		3.48	14.8
Fe_2O_3	1.74		4.03	35.8
SiO_2	4.17		10.8	43.0
Na_2O	0.12		0.19	0.33
K_2O	0.05		0.38	1.16
TiO_2	0.01		0.10	0.62
CO_2	7.3		9.0	0.12
Cl^-	0.22		0.19	0.19
Cu (ppm)	10		130	70
Pb (ppm)	40		80	100
Cd (ppm)	2		3	6
Hg (ppm)	$<.03$		$<.03$	.06
As (ppm)	10		3	34
Se (ppm)	1		1	1

Note (a): total sulfur, calculated as SO_3

Note (b): total sulfur less sulfite sulfur, calculated as SO_3

Note (c): sulfite sulfur, calculated as SO_2

The ability to stabilize a FGD sludge is greatly affected by its water content. As the solids content of the sludge is increased, the void ratio decreases producing material with a higher dry density. Smaller quantities of fixative are required to harden sludges with low void ratios because the individual particles are closer and can thus react more readily with each other and the hardening agent. The optimum moisture content for maximum compaction of FGD sludges solids is 30-40%.

Based on previous experience, as well as typical ratios of sulfur to ash in coal, the sludges were mixed with fly ash in ratios ranging from 0:1 to 1.5:1 parts by weight fly ash to dry scrubber solids. Varying percentages of fixative were added to aid the cementing reaction. Four stabilizing agents: lime, hydrated lime, carbide lime and Portland cement, were chosen for evaluation as "fixatives".

The following series of tests were performed during the laboratory screening phase to determine the landfill behavior of stabilized sludge mixtures.

1. Unconfined compressive strength
2. Permeability
3. Leachate analysis

Complete data from the laboratory tests are contained in Appendix A.

UNCONFINED COMPRESSIVE STRENGTH

The unconfined compressive strength (UCC) test is a standard soil mechanics test which measures the compressive strength of a cylinder of stabilized sludge to which no lateral support is given. Compressive strength tests were run using a Soil Test Model AP170B Compression Testing Machine on stabilized sludge mixtures which had been cured in a humid environment for sixty (60) days. The shear strength (taken as 1/2 the unconfined compressive strength), gives an indication of the bearing capacity of the landfilled sludge after an initial cure period. Table 3 lists UCC strengths measured

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TABLE 3. LABORATORY PROGRAM SLUDGE TEST SAMPLE IDENTIFICATION

Field Mix	Sample No.	Sludge Composition	Fly Ash Sludge Ratio	Fixative	Permeability cm/s	60-Day Unconfined Compressive Strength	
						MPa	T/ft^2
1	P1	24% C.L.	1:1	5% C.L.(a)	7.6×10^{-5}	b	
	P2	24% C.L.	1:1	25% C.L.	8.5×10^{-5}	b	
2	P3	42% C.L.	1:1	5% C.L.	2.9×10^{-6}	0.78	8.2
	P4	42% C.L.	1:1	15% C.L.	7.7×10^{-7}	0.50	5.2
3	P5	42% C.L.	1:1	% CaO (c)	1.1×10^{-6}	0.86	9.0
5	P6	55% C.L.	1:1	None	5.7×10^{-7}	1.40	14.6
6	P7	55% C.L.	1:1	3% C.L.	2.1×10^{-7}	2.40	25.1
	P8	55% C.L.	0:1	None	3.9×10^{-6}	Not Tested	
4	P9	55% C.L.	0:1	5% CaO	4.5×10^{-7}	0.88	9.2
7	P10	65% CaO	1:1	None	7.0×10^{-6}	0.29	3.0
	P11	50% CaO	0.5:1	3% P.C.(d)	1.4×10^{-5}	0.14	1.5
	P12	50% CaO	0.5:1	10% P.C.	2.9×10^{-6}	0.56	5.9
	P13	50% CaO	1.5:1	3% P.C.	2.5×10^{-6}	0.64	6.7
8	P14	50% CaO	0.5:1	3% CaO	4.1×10^{-6}	0.70	7.3
	P15	50% CaO	0.5:1	10% CaO	2.3×10^{-6}	0.87	9.1
9	P16	50% CaO	1.5:1	3% CaO	5.7×10^{-7}	1.20	12.5
	P17	50% CaO	0.5:1	5% P.C.	3.5×10^{-5}	0.15	1.6
10	P18	50% CaO	1:1	3% P.C.	5×10^{-5}	0.52	5.4
	P19	50% CaO	1:1	5% P.C.	1.14×10^{-5}	0.27	2.8
	P20	50% CaO	0.5:1	5% CaO	1.5×10^{-5}	0.82	8.6
11	P21	50% CaO	1:1	3% CaO	2.94×10^{-6}	0.81	8.5
12	P22	50% CaO	1:1	3% $Ca(OH)_2$(e)	9.2×10^{-6}	0.68	7.1
	P23	50% CaO	1:1	5% CaO	1.05×10^{-6}	1.90	19.8
	P24	50% CaO	0.5:1	10% $Ca(OH)_2$	1.8×10^{-5}	0.66	6.9
	P25	50% CaO	1.5:1	3% $Ca(OH)_2$	3.8×10^{-6}	1.31	13.7

Notes:(a) C.L. - Carbide Lime
(b) Too weak (soft) to test
(c) CaO - Commercial Lime
(d) P.C. - Portland Cement
(e) $Ca(OH)_2$ Commercial Quicklime

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for the sludge mixtures tested. Generally, a mixture having an unconfined compressive strength greater than 0.1 MPa (1.0 tons/ft^2) would be capable of providing a stable landfill which could be reclaimed for recreational use. The higher strength mixtures would be capable of supporting more intensive uses, such as structural loads.

As seen in Table 3, the majority of the laboratory samples met the strength criteria of 0.1 MPa (1.0 tons/ft^2). Therefore, the mixtures selected for permeability testing were chosen to provide a broad evaluation of different fixatives, fly ash ratios, and moisture contents. Twenty-five mixtures were chosen for permeability testing.

PERMEABILITY

The permeabilities of the sludge mixtures were measured using a falling head permeameter. Sludge mixtures were cured under saturated conditions for thirty (30) days before permeability testing. Table 3 lists the permeability coefficients measured in the laboratory tests. For purposes of comparison, typical coefficients are: 0.4 cm/sec for a uniform coarse sand, 10^{-4} cm/sec for a silty sand, and 10^{-7} cm/sec for clay. The majority of the stabilized sludge mixtures tested were relatively impervious, with coefficients of permeability ranging from 10^{-4} to 10^{-7} cm/sec. As shown in Figure 1, permeability appeared to vary inversely with the UCC strength in the laboratory samples.

LEACHATE ANALYSES

During permeability testing, the leachates from the sludge samples were collected for chemical analysis. The first and second pore volumes were combined, as were the fifth and sixth, to obtain sufficient sample for the number of analyses desired. These two samples were analyzed for the major and trace elements listed in Table 4. The trace elements marked with an asterisk are those which appear in the Resource Conservation and Recovery Act list of contaminants which will be used to define toxicity. These substances are also regulated under EPA's National Primary Drinking Water Standards. (Table 1)

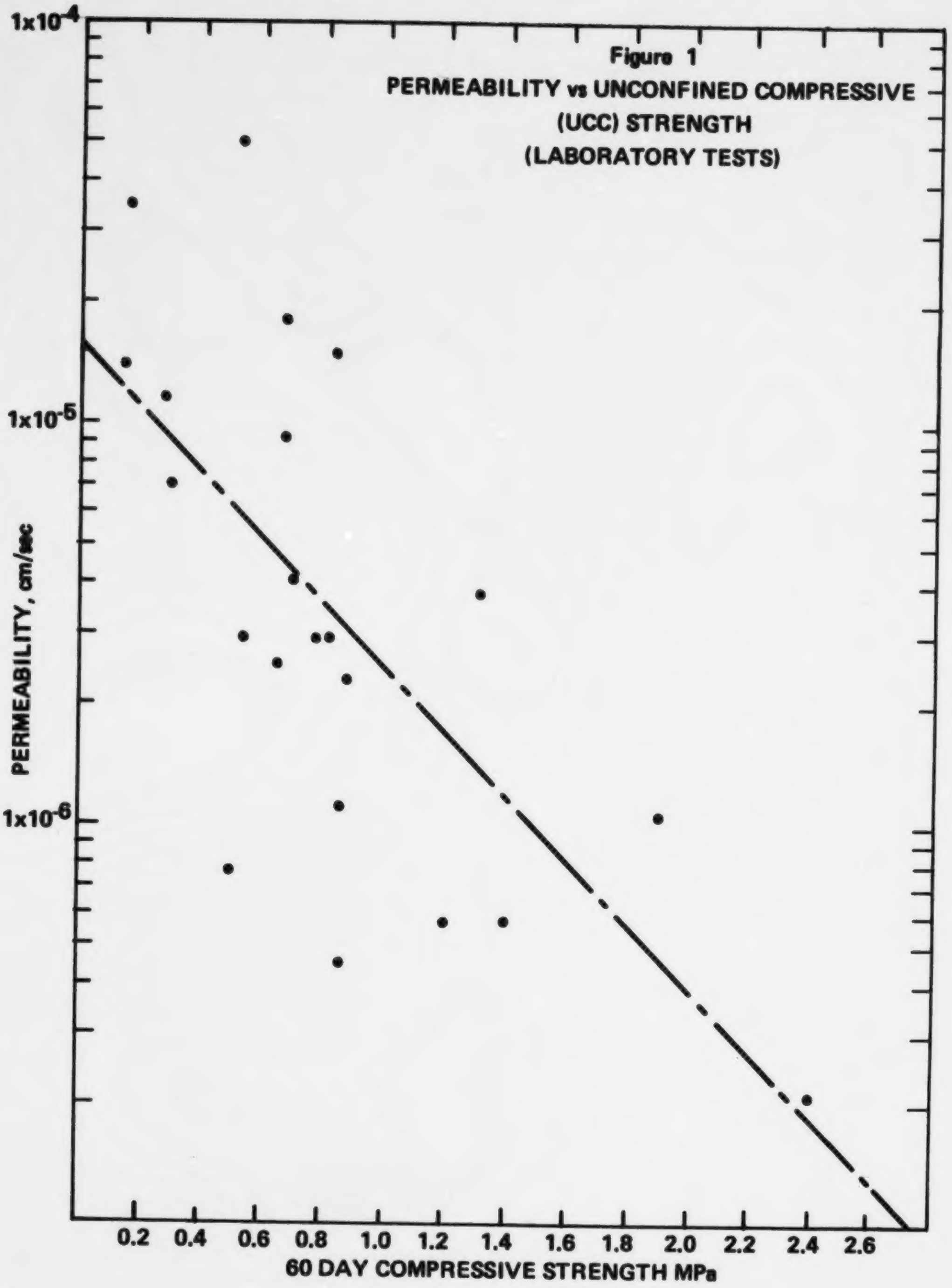

Figure 1
PERMEABILITY vs UNCONFINED COMPRESSIVE (UCC) STRENGTH (LABORATORY TESTS)

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TABLE 4. LEACHATE ANALYSES - LIMITS and METHODS

Determined on Both Laboratory and Field Samples

		Detection Limit (PPM)	Methods of Test
Calcium	Ca	0.05	Atomic Absorb.
Magnesium	Mg	0.01	Atomic Absorb.
Carbonate	CO_2	1.0	CO_2 Absorption Train
Sulfite	SO_3	1.0	Iodine-Iodate Titration
Sulfate	SO_4	1.0	Barium Perchlorate Titration
Chloride	Cl	0.05	Mercuric Nitrate Titration
Copper	Cu	0.02	AA (flame)
*Lead	Pb	0.001	AA (furnace)
*Cadmium	Cd	0.01	AA (flame)
*Mercury	Hg	0.001	AA (flameless)
*Arsenic	As	0.001	AA (furnace)
*Selenium	Se	0.001	AA (furnace)

Determined on Field Samples Only

		Detection Limit (PPM)	Methods of Test
Iron	Fe	0.03	AA (flame)
Zinc	Zn	0.004	AA (flame)
*Chromium	Cr	0.01	AA (flame)
Aluminum	Al	0.1	AA (flame)
Manganese	Mn	0.01	AA (flame)
Sodium	Na	0.002	Emission
Nickel	Ni	0.04	AA (flame)
*Barium	Ba	0.1	AA (flame)
*Silver	Ag	0.01	AA (flame)
Fluoride	F	0.01	Spec. Ion Elec.
Boron	B	0.1	Carminic Acid Colorimetric
Beryllium	Be	0.01	AA (flame)
Vanadium	V	1.0	AA (flame)
Nitrate	NO_3	1.0	Brucine Sulfate Colorimetric

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Leachate analysis for all laboratory samples are shown in Appendix B. The fixation reaction minimizes the release of contaminants to the leachate as can be seen by comparing the stabilized sludge leachate analysis to a sludge and sludge/fly ash mixture containing no fixative (Table 5). In addition, the quality of the leachates improved with time in the stabilized mixtures, indicating that the fixation reaction continues for some period after initial placement. A number of the mixtures had very low permeabilities, and the necessary pore volumes were never collected.

Based on the laboratory tests, a total of 12 mixtures were chosen for further evaluation under field conditions. The field mixtures were chosen from laboratory samples which developed strengths greater than 0.1 MPa (1 ton/ft^2) and had low permeabilities. Field mixtures are identified by number in Table 3.

TABLE 5. LABORATORY LEACHATE ANALYSES

	Sludge Only 55% Carbide Lime 0:1 Fly Ash to Sludge No Fixative		Mix 7 65% Comm. Lime 1:1 Fly Ash to Sludge 3% P. C.		Mix 10 50% Comm. Lime 1:1 Fly Ash to Sludge No Fixative		Mix 9 50% Comm. Lime 1:1 Fly Ash to Sludge 3% CaO	
Pore Volume#	1 & 2	5 & 6	1 & 2	5 & 6	1 & 2	5 & 6	1 & 2	5 & 6*
Cont. µmhos/cm	6850	2500	2850	2000	2550	575	1800	
pH	7.8	7.5	7.8	7.7	9.2	8.0	9.3	
TDS (ppm)	4100	1500	1700	1200	1400	345	1100	
Cl^- (ppm)	345	<5	10	15	20	<5	15	
$SO_3^=$ (ppm)	30	--	40	--	30	20	230	
Cd (ppm)	0.02	<0.01	0.02	<0.01	0.01	0.01	<0.01	
Cu (ppm)	0.06	0.02	0.02	0.02	<0.02	<0.02	<0.02	
Pb (ppm)	0.2	0.1	0.1	0.1	--	--	<0.1	
Hg (ppm)	0.001	0.002	0.018	0.001	0.002	0.002	0.001	
As (ppm)	0.05	0.01	0.03	0.03	0.007	0.003	0.01	
$SO_4^=$ (ppm)	5390	1960	1580	1470	1320	218	440	
Ca (ppm)	260	300	320	300	650	110	6.7	
Se (ppm)	0.023	0.002	--	0.003	0.010	<0.001	0.008	
Mg (ppm)	--	--	0.18	0.16	0.10	0.04	0.02	

* Due to low permeability of samples, pore volumes 5 & 6 were not available after 60 days of collection.

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SECTION 6
FIELD DEMONSTRATION

SCRUBBER AND PILOT WASTE HANDLING SYSTEM

Process Configurations

The flue gas desulfurization system at Paddy's Run Unit No. 6 consists of two scrubber modules which operate in parallel at full load. Figure 2 shows the overall arrangement of the scrubbing system during the collection of the by-product used during this study. Inlet SO_2 concentrations were about 2000 ppm at a gas flow rate of 180,000 Nm^3/hr (175,000 ACFM) with the boiler at half load. A liquid/gas ratio (L/G) of 7.5 l/Nm^3 (28 gal/1000 CFM) was maintained during the test program. For Phase I, Carbide Lime Operation, SO_2 removal ranged between 75 and 83 percent. A slurry inlet pH of 8 was controlled over the six week period required to collect and process sufficient by-product to fill six impoundments.

During Phase II, Commercial Lime Operation, about 2000 ppm magnesium was added to allow assessment of its effect on system operation. The slurry inlet pH of 8 was maintained and SO_2 removal exceeded 90%. The sludge by-product was processed and all ten remaining impoundments were filled within one month.

A schematic flow diagram of the waste material handling system used to process the sludge during the field demonstration phase is shown in Figure 3.

The entire thickener underflow was pumped around an 244m(800 ft.) circulation loop. A slip stream taken from the loop was used to fill a 25.4 cm (10-inch) dia. x 3m (10-ft.) high slurry surge tank. The remaining slurry was then returned to the vacuum filter which is normally used to dewater the

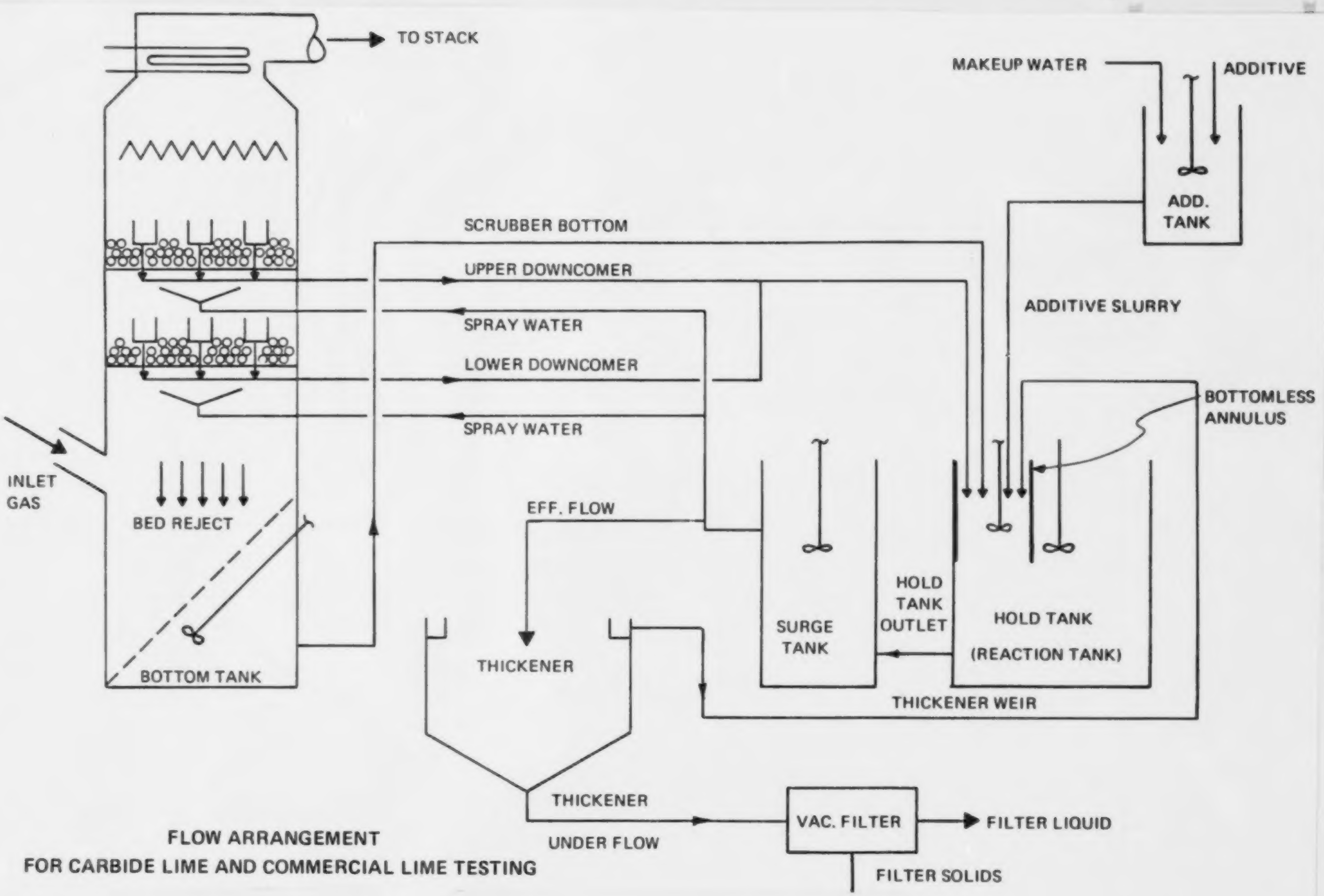
TO STACK
MAKEUP WATER
ADDITIVE
ADD. TANK
SCRUBBER BOTTOM
UPPER DOWNCOMER
SPRAY WATER
LOWER DOWNCOMER
SPRAY WATER
ADDITIVE SLURRY
BOTTOMLESS ANNULUS
INLET GAS
BED REJECT
BOTTOM TANK
EFF. FLOW
THICKENER
SURGE TANK
HOLD TANK OUTLET
HOLD TANK (REACTION TANK)
THICKENER WEIR
THICKENER UNDER FLOW
VAC. FILTER
FILTER LIQUID
FILTER SOLIDS
FLOW ARRANGEMENT
FOR CARBIDE LIME AND COMMERCIAL LIME TESTING

FIGURE 2

FLOW ARRANGEMENT - FGD SYSTEM

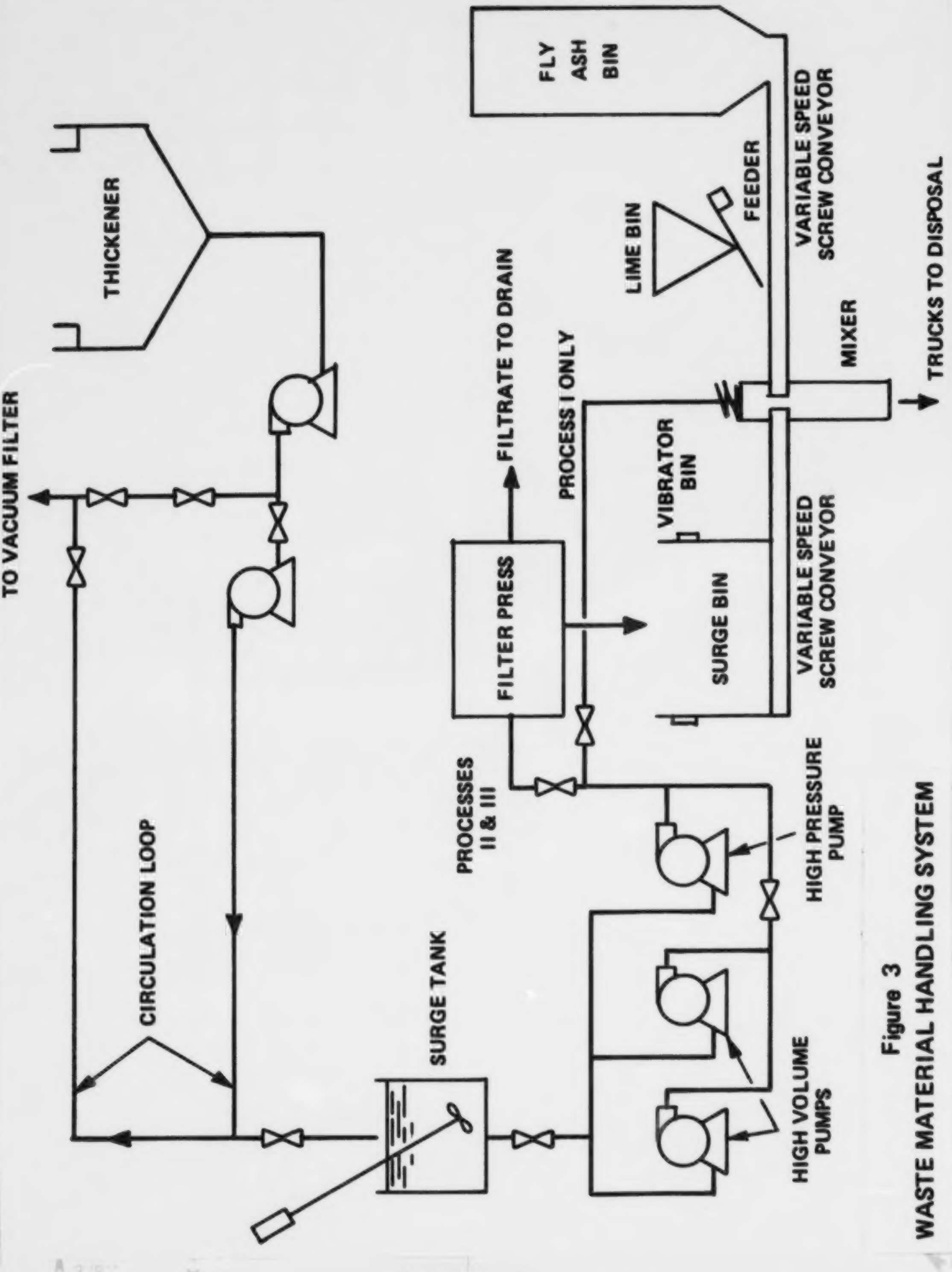
THICKENER
TO VACUUM FILTER
CIRCULATION LOOP
SURGE TANK
FILTER PRESS
FILTRATE TO DRAIN
PROCESS I ONLY
PROCESSES II & III
HIGH PRESSURE PUMP
HIGH VOLUME PUMPS
SURGE BIN
VIBRATOR BIN
VARIABLE SPEED SCREW CONVEYOR
MIXER
LIME BIN
FEEDER
VARIABLE SPEED SCREW CONVEYOR
FLY ASH BIN
TRUCKS TO DISPOSAL

Figure 3 WASTE MATERIAL HANDLING SYSTEM

bulk solids prior to disposal. Three separate processes were used to prepare the mixtures for disposal.

For Process I, the slurry was pumped from the surge tank through a 3.8 cm (1.5 in.) magnetic flowmeter directly to the mixer into which additive and fly ash were being metered.

In Process II, the sludge was dewatered in the filter press to produce a filter cake of the same solids content as the filter cake from the commercial rotary vacuum filter. When removed from the filter press, the filter cake fell into a surge bin from which it was metered into the mixer by means of a 15.2 cm (6-inch) variable speed screw (VSS) conveyor. Fly ash and additive were simultaneously metered into the mixer.

Process III was planned to evaluate the use of a filter press operating at high pressure to dewater the sludge. The filter press provides a means of obtaining a much drier cake than can be obtained with a vacuum filter.

The filter cake was stabilized with fly ash. All mixtures were discharged into trucks, transported 11.2 Km (7 miles) to LG&E's Cane Run Plant and placed in the test impoundments.

Waste Handling Process Equipment

The essential pieces of equipment in the layout are the filter press, the pumps and piping, the storage silos for fly ash and additive, the screw conveyors for transporting the filter cake and fly ash and, a mixer for combining the filter cake, additive and fly ash (Figure 3).

Pumps--

Three air driven pumps, acting in parallel, were used to fill the filter press. Initially, two low pressure, high volume diaphragm pumps fill the filter press while the back pressure is low. When the pressure in the filter press reaches 621 KPa (90 psi), a high pressure, low volume pump activates and pumps until the desired pressure in the filter press is achieved (897 KPa (130 psi)).

Filter Press--

The recessed plate filter press used in this demonstration has the capability of dewatering 2200 Kg/hr (1000 lbs/hr) of dry solids. The filter press has 122 cm (48 in.) square polypropylene filter plates with ten cake chambers. The holding capacity of the press is 0.5 m^3 (20 ft^3). When the filtration cycle was completed, the press opened and the cake was discharged into the filter cake surge hopper.

Filter Cake Feed System--

For Phase I, the filter cake surge hopper had a rectangular inlet opening of 132 x 183 cm (52 inches by 72 inches) that tapered to 17.8 x 183 cm (7 inches x 72 inches) at the bottom where it discharged into a 15.2 cm (6 inch) NSS conveyor used to meter the filter cake to the mixer.

For Phase II, the surge hopper was modified to discharge into a four screw, live bottom bin conveyor (Figure 4). The live bottom bin conveyor discharged the cake into the 15.2 cm (6 inch) VSS conveyor.

Fly Ash and Fixative System--

Fly ash was conveyed to a 4.2 m^3 (150 ft^3) surge hopper by a gravity chute from the existing LG&E air slide conveyor. The fly ash was metered and conveyed to the mixer by means of a 10.2 cm (4 inch) VSS conveyor.

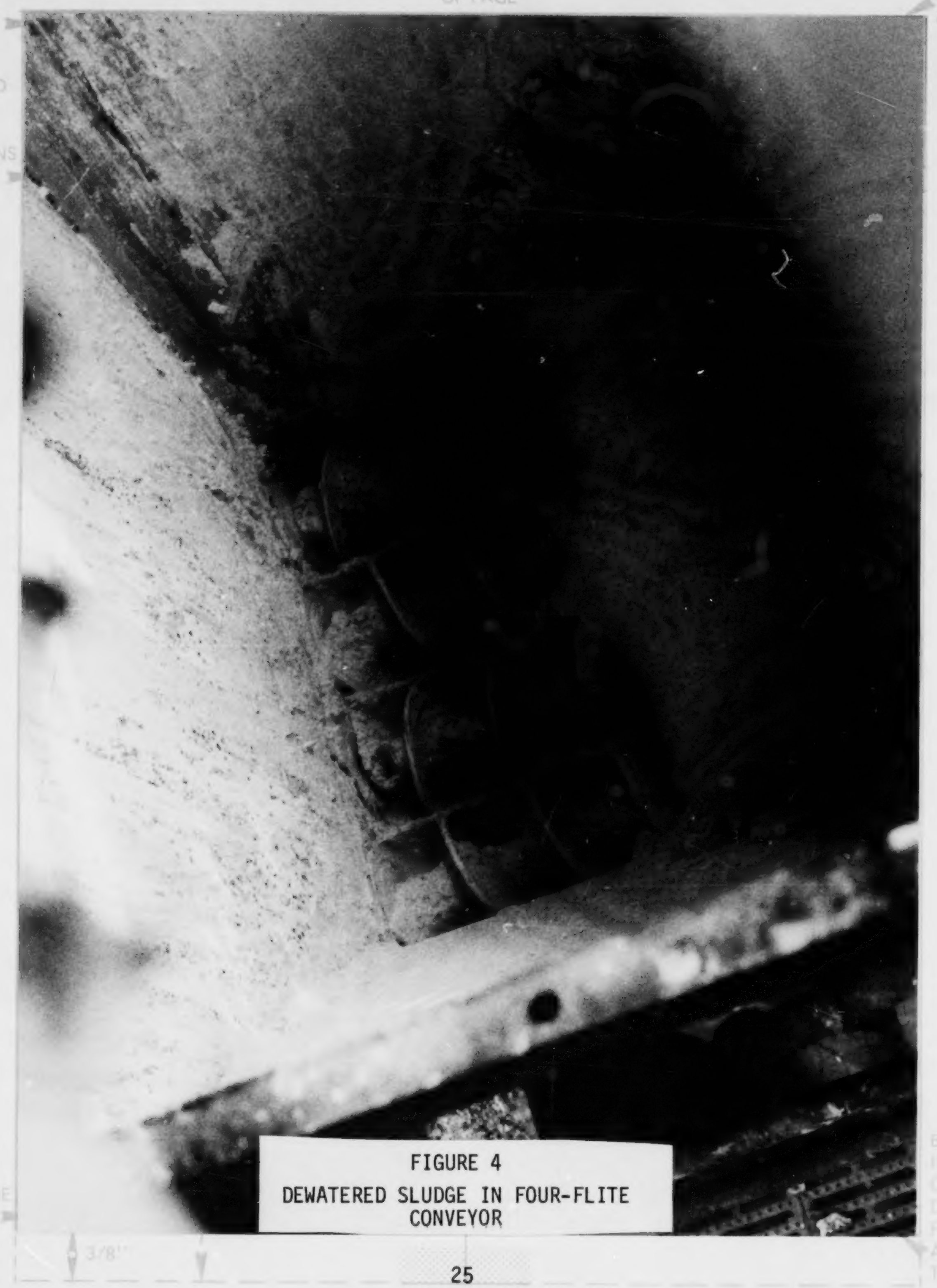

FIGURE 4
DEWATERED SLUDGE IN FOUR-FLITE CONVEYOR

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Dry fixative was stored in an 0.5m^3 (18 ft^3) hopper. The fixative was metered into the top of the 10.2cm (4 inch) VSS conveyor by means of a vibrating feeder.

Changes to the fly ash handling system were made during the final stages of Phase II and are described in the following section.

Mixer--

The continuous mixer used to combine the sludge, fly ash, and additive was a C-E Bauer, Single Disc Mill. The mill consisted of a stationary disc and a rotating disc separated by a distance of 2.5 cm (0.1 inch) or less. The material to be mixed was injected into gaps between the disc by a hollow feed screw through the center of the stationary disc. The material was sheared and mixed as centrifugal force moved it toward the outer edge of the rotating disc. The mixed material was then discharged directly from the bottom of the mill into the trucks used to transport the mixes to the test demonstration sites.

Prior to Phase II, modifications were made to the feed screw to separate the fly ash and filter cake feed points; the wet-dry interface was moved as close to the mill plate as possible. Additional scraper bars were also added to the rotating mill plate. A rotary feed valve and pneumatic fly ash transport system were added to feed the fly ash through the hollow mill feed screw directly to the rotating disc.

For this method of fly ash feed, the fixative was metered batchwise directly into the live bottom hopper with each batch of filter cake (Figure 5).

In addition, a large horsepower reversible drive motor was installed on the mill feed screw to provide adequate power.

The percent solids data were obtained for all mixes by running Quickee® moisture determinations on the filter cake and final mix batches. In this procedure, occluded moisture is determined by reaction with an excess of calcium carbide to form acetylene gas. The pressure of this gas is read directly as percent moisture on a calibrated pressure gage.

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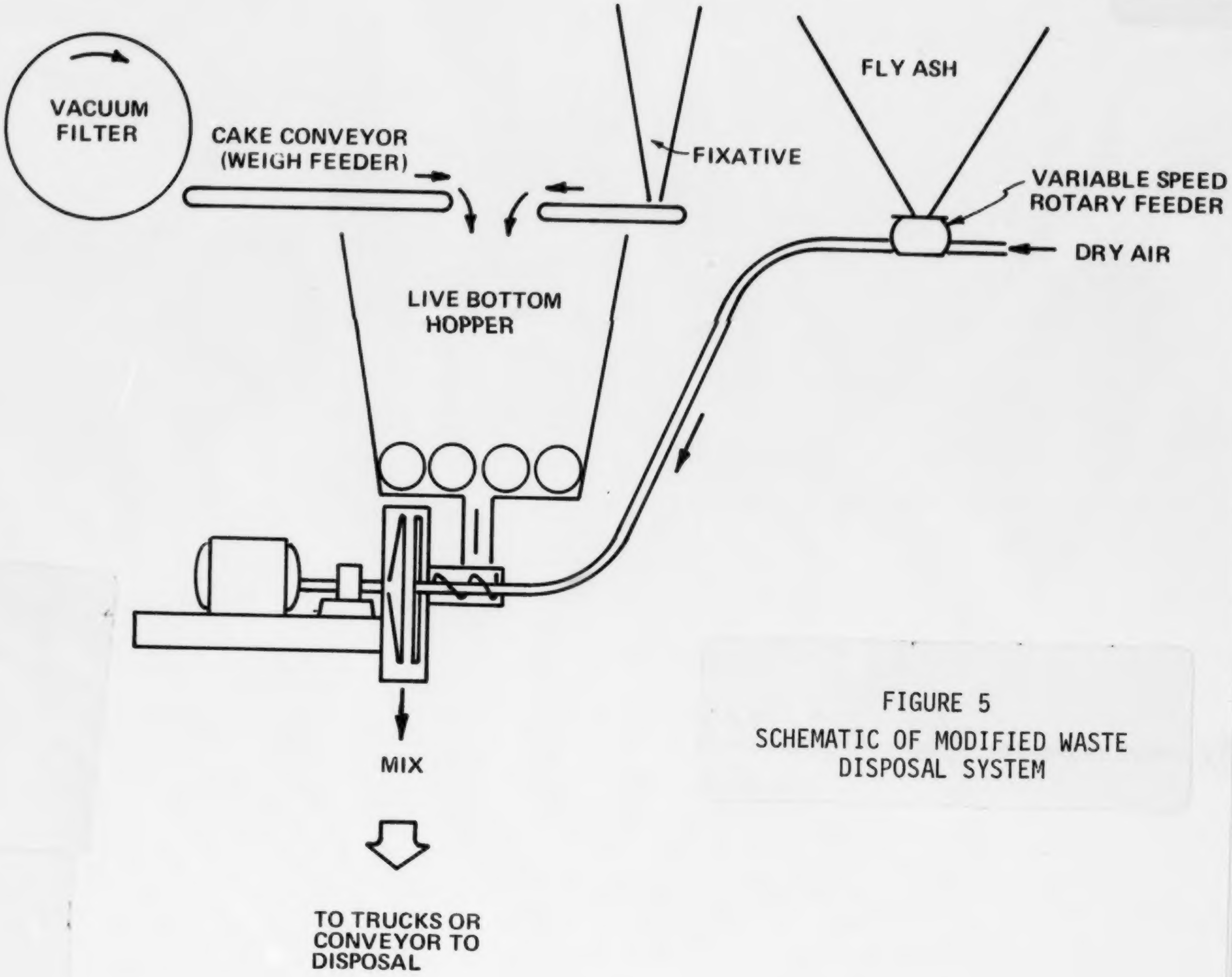
VACUUM FILTER
CAKE CONVEYOR (WEIGH FEEDER)
FIXATIVE
FLY ASH
VARIABLE SPEED ROTARY FEEDER
DRY AIR
LIVE BOTTOM HOPPER
MIX
TO TRUCKS OR CONVEYOR TO DISPOSAL

FIGURE 5
SCHEMATIC OF MODIFIED WASTE DISPOSAL SYSTEM

FIELD IMPOUNDMENTS

General Description

Three general criteria were selected to characterize acceptable landfill disposal practice. The landfill must (1) not cause contamination of groundwater by leaching, or surface water by runoff or erosion, and (2) must provide a material with minimum structural integrity

A series of ten commercial above-ground swimming pools and five large impoundments (Figure 6) were used as monitored disposal sites for sludge-fly ash mixtures.

Leachate samples were collected for analysis one week after filling each impoundment. Thereafter, leachate was collected at two or three month intervals. The leachate collection containers were emptied and cleaned following each sampling period. These leachates were analyzed for dissolved ions including both major and trace constituents. In some instances, either no leachate sample was produced or insufficient sample was available to allow complete analysis. In the latter case, an analytical priority was established to provide maximum information from the available sample.

Using National Weather Service precipitation data, the maximum water which was available to percolate through the test sites was calculated. This amount of liquid available was translated into pore volumes for each test impoundment. Analysis of the rainfall data indicates that the large impoundments were exposed to 2.0 to 2.3 pore volumes of precipitation while the small impoundments had seen 3.0 to 3.7 pore volumes, after 600 days. Thus, the laboratory leachate data previously discussed would represent 4 to 6 years of comparable field impoundment leachate analysis. (Of course, in many instances, runoff and surface evaporation at the field sites reduced the quantity of liquid prior to its passage through the sludge; therefore, the pore volume estimates for the field are high).

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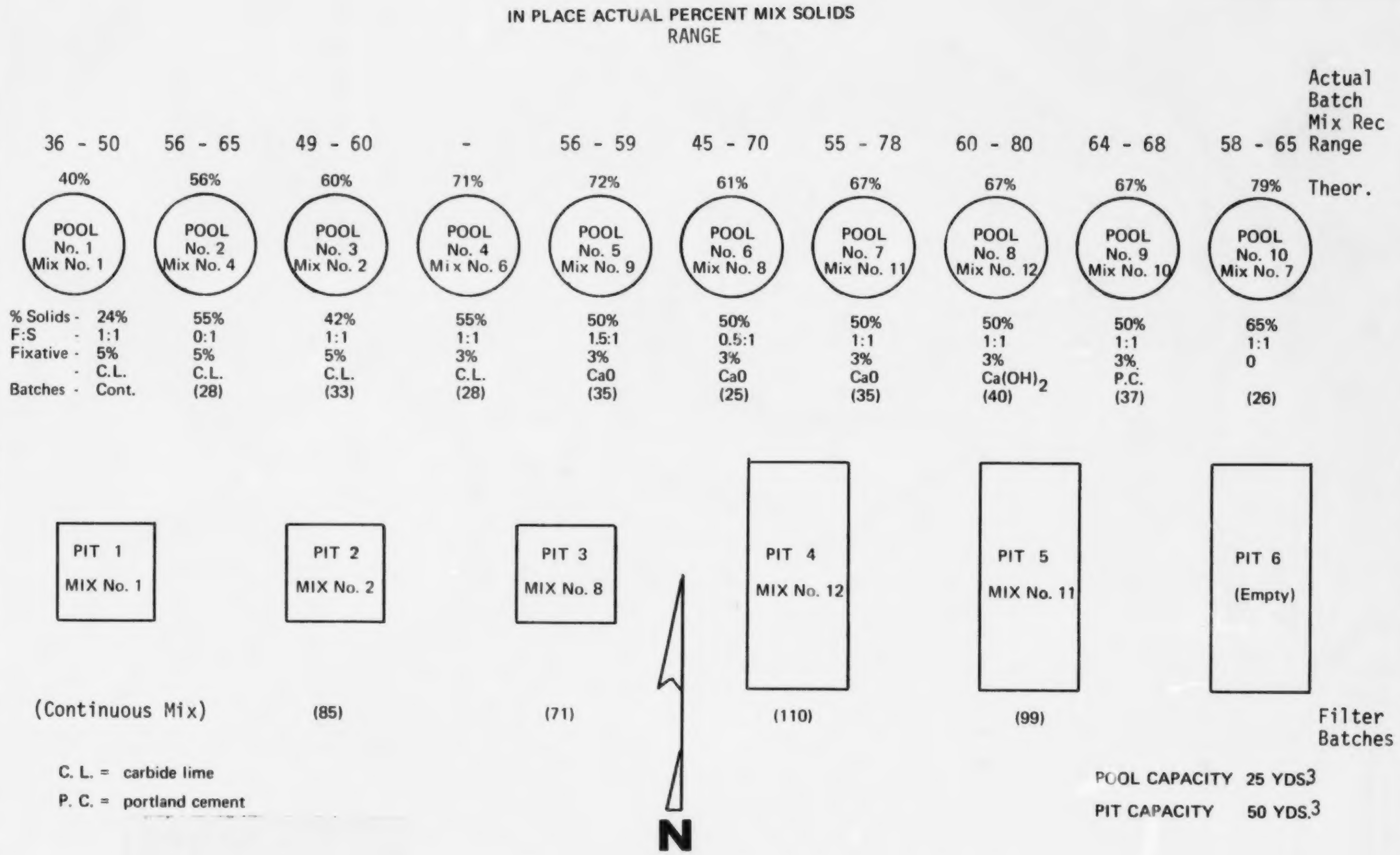
IN PLACE ACTUAL PERCENT MIX SOLIDS
RANGE
Actual Batch Mix Rec Range
Theor.
36 - 50
40%
POOL No. 1 Mix No. 1
% Solids - 24%
F:S - 1:1
Fixative - 5%
- C.L.
Batches - Cont.
56 - 65
56%
POOL No. 2 Mix No. 4
55%
0:1
5%
C.L.
(28)
49 - 60
60%
POOL No. 3 Mix No. 2
42%
1:1
5%
C.L.
(33)
-
71%
POOL No. 4 Mix No. 6
55%
1:1
3%
C.L.
(28)
56 - 59
72%
POOL No. 5 Mix No. 9
50%
1.5:1
3%
CaO
(35)
45 - 70
61%
POOL No. 6 Mix No. 8
50%
0.5:1
3%
CaO
(25)
55 - 78
67%
POOL No. 7 Mix No. 11
50%
1:1
3%
CaO
(35)
60 - 80
67%
POOL No. 8 Mix No. 12
50%
1:1
3%
Ca(OH)2
(40)
64 - 68
67%
POOL No. 9 Mix No. 10
50%
1:1
3%
P.C.
(37)
58 - 65
79%
POOL No. 10 Mix No. 7
65%
1:1
0
(26)
PIT 1 MIX No. 1
PIT 2 MIX No. 2
PIT 3 MIX No. 8
PIT 4 MIX No. 12
PIT 5 MIX No. 11
PIT 6 (Empty)
(Continuous Mix)
(85)
(71)
(110)
(99)
Filter Batches
N
C. L. = carbide lime
P. C. = portland cement
POOL CAPACITY 25 YDS.3
PIT CAPACITY 50 YDS.3

SLUDGE IMPOUNDMENT SITES
FIGURE 6

Small Scale Impoundments

One type of disposal site consisted of small scale impoundments (Figures 7,8). The primary purpose of these test sites was to provide a means of determining the quality of the leachate and runoff from the test mixtures under field conditions. The small-scale impoundments were ten lined above ground swimming pools with a capacity of about 19 m^3 (25 yd^3). Four of these were used for sludge mixtures from a scrubbing system using carbide lime as an absorbent and six for sludge from a system using commercial lime.

The bottom 15.2 cm (6 inches) of each pool contained non-reactive graded gravel to facilitate collection of the leachate. The leachate drained by gravity to a collection tank.

Runoff was collected from the surface of the small scale impoundments through a gravel filter held in place by a coarse screen. This procedure insured that drainage was always provided regardless of the level to which the sludge consolidated. The runoff was analyzed for dissolved species at the same intervals as that indicated for the leachate.

Large Scale Impoundments

The small scale impoundments provided a convenient means of determining maximum leaching rates and leachate quality without any interference from local surroundings. In the actual field site, the landfill will either absorb or release moisture to the surrounding soil. The large scale impoundment areas provided a means of assessing the impact of the disposal material in terms of its effect on local soil moisture and the quality (dissolved ions) of the moisture in the soil and of the water in the aquifer beneath the disposal sites.

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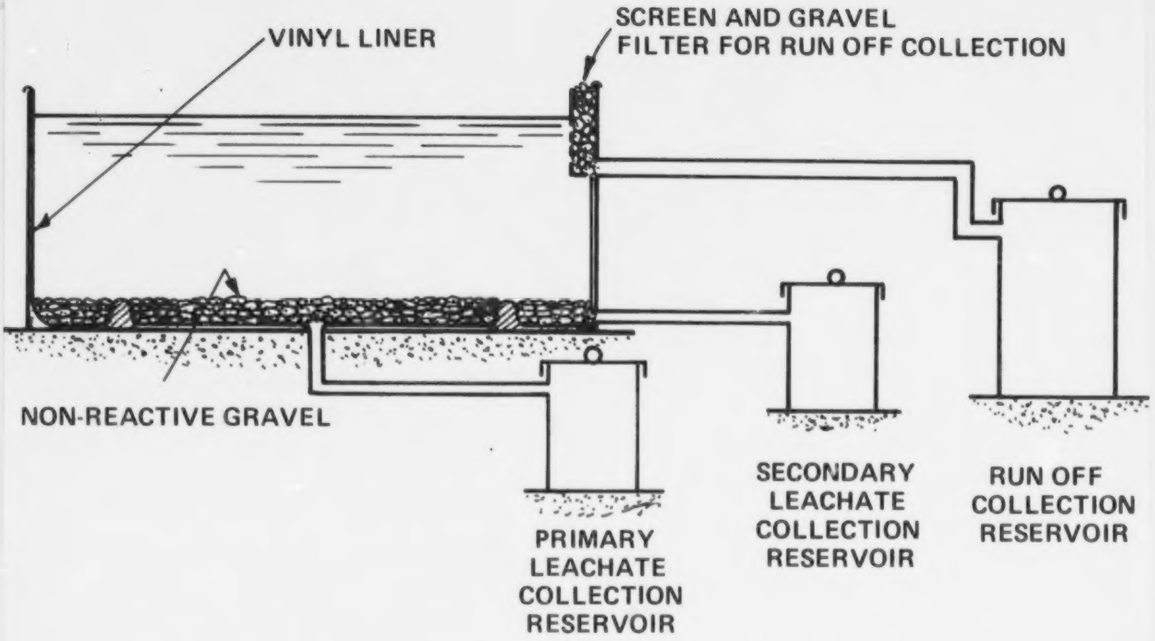
VINYL LINER
SCREEN AND GRAVEL FILTER FOR RUN OFF COLLECTION
NON-REACTIVE GRAVEL
PRIMARY LEACHATE COLLECTION RESERVOIR
SECONDARY LEACHATE COLLECTION RESERVOIR
RUN OFF COLLECTION RESERVOIR

FIGURE 7

SMALL SCALE IMPOUNDMENT (POOLS)

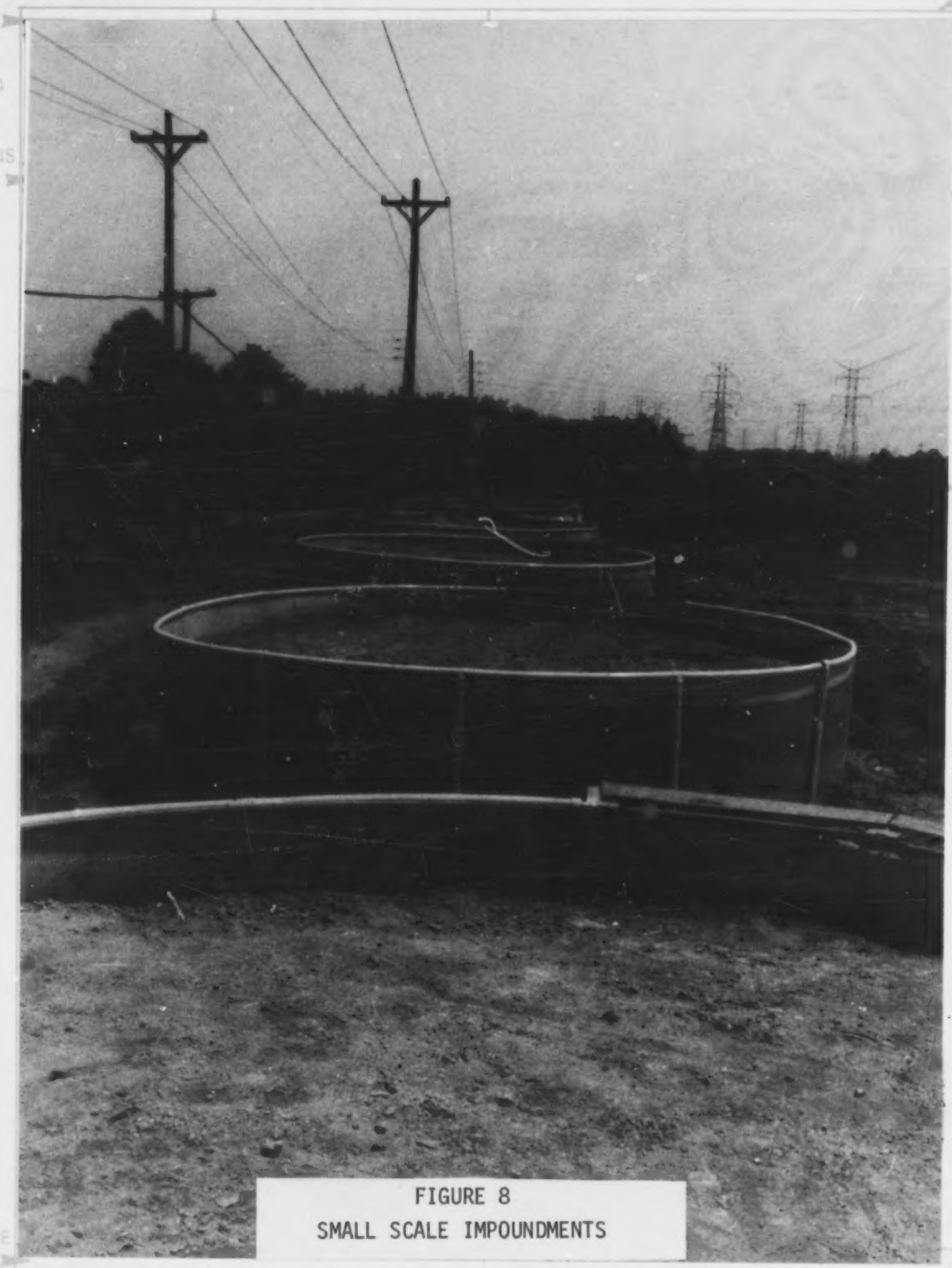

FIGURE 8
SMALL SCALE IMPOUNDMENTS

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Five large scale impoundment areas were excavated, each with a capacity of about 38 m^3 (50 yd^3). The disposal sites, located in natural soil are of two styles: approximately (4.9m x 4.9m x 2.4m) 16 ft, 16 ft x 8 ft tapers and (9.1m x 2.4m x 1.2m) 30 ft x 8 ft x 4 ft pits. (Figures 9 and 10) Two contained carbide sludge mixtures while the remainder contained mixtures of commercial lime sludge (Figure 6). Soil moisture was monitored by suction lysimeters located 15.2, 61.0 and 182.8cm (6, 24, and 72 inches) beneath the bottom of the test site.

Figure 9

SCHEMATIC - LARGE SCALE IMPOUNDMENTS (PITS)

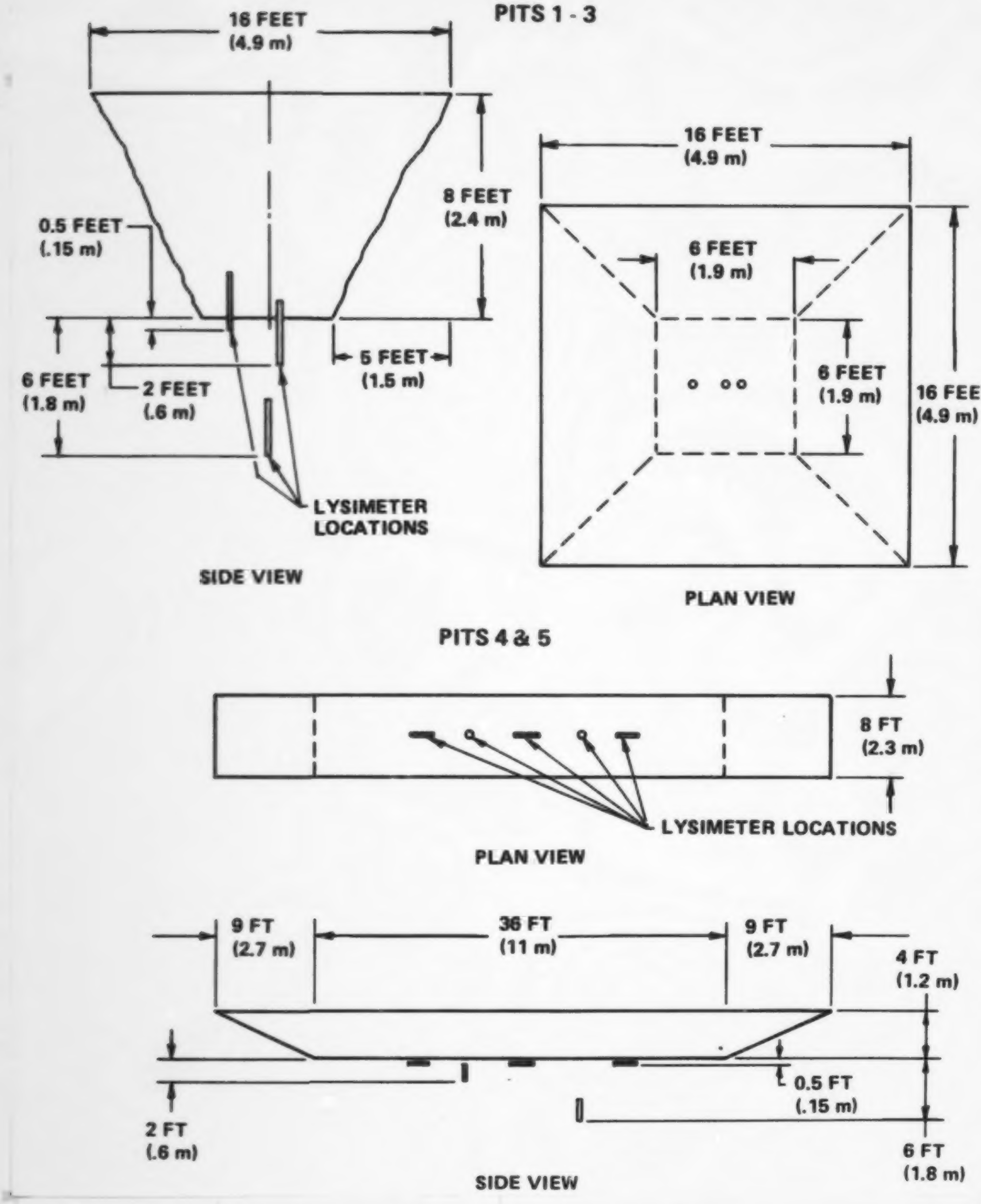
PITS 1 - 3
16 FEET
(4.9 m)
8 FEET
(2.4 m)
0.5 FEET
(.15 m)
5 FEET
(1.5 m)
6 FEET
(1.8 m)
2 FEET
(.6 m)
LYSIMETER LOCATIONS
SIDE VIEW
16 FEET
(4.9 m)
6 FEET
(1.9 m)
6 FEET
(1.9 m)
16 FEET
(4.9 m)
PLAN VIEW
PITS 4 & 5
8 FT
(2.3 m)
LYSIMETER LOCATIONS
PLAN VIEW
9 FT
(2.7 m)
36 FT
(11 m)
9 FT
(2.7 m)
4 FT
(1.2 m)
0.5 FT
(.15 m)
2 FT
(.6 m)
6 FT
(1.8 m)
SIDE VIEW

FIGURE 10
LARGE SCALE IMPOUNDMENTS

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BOTTOM OF IMAGE AREA OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
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EVALUATION OF FIELD MIXTURES

Physical Testing Methods

In-situ vane shear strength tests were performed at nominal intervals of 0, 30, 90, 180, and 360 days, with limited additional testing at 450, 650, and 725 days after placement. Vane shear tests were made at 15.2 cm (6 inch) depth intervals where possible.

Plate load tests were conducted on two of the large subsurface impoundments when their shear strength exceeded the capacity of the vane shear test. In these tests, a steel loading plate 929 cm^2 (1 ft^2) was placed on the surface of the impoundment after the surface had been leveled and swept free of debris. Dial gauges were positioned at the corners of the steel plate to measure the downward movement of the plate corners under load, a hydraulic jack was used to exert downward force on the steel plate. The load was cycled to investigate rebound characteristics of the material.

Laboratory unconfined compressive strength tests and permeability tests were performed on samples obtained by Shelby tube or rotary bore at the same test interval as the vane shear tests. Continuous core samples were obtained on the sludge mixtures in selected impoundments by use of 76.2 cm (30 inch) length and 5.1 cm (2 inch) diameter Shelby tubes. A drilling rig was used to obtain samples when the materials were too firm for manual sampling. The laboratory unconfined compression test samples were prepared from 20.3 cm (8 inch) lengths of sample from the ends of each Shelby tube in accordance with ASTM Method D2166.

A number of factors influenced the physical testing of the sludge mixtures in both the small and large impoundments. These factors must be considered when interpreting the test results. First, the brittle nature of many of the mixtures as well as freezing weather caused severe sample disturbance when the Shelby tube core sampler was used. The use of a drilling rig to secure samples during the 1978 sampling program reduced,

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but did not entirely alleviate, sample disturbance. This sampling disturbance reduced the strength of the sludge mixture core samples when tested in the laboratory unconfined compression tests. The in-situ vane shear strength tests are probably the most reliable data; however, the limit of the vane shear device is 0.28 MPa (3 Tons/ft^2). Limited in-situ testing using a plate load test indicated that the true bearing strength of some mixtures may be much higher than the limit of vane shear device.

Second, the inability to completely compact the mixtures, particularly in the small above-ground impoundments (where concern for the retaining wall integrity prevented vigorous compacting), caused some variation in density and strength with depth.

Laboratory permeability tests were performed on 12-15 cm (5 - 6 inch) lengths of sample cut from the center of each Shelby tube core sample. Testing was done on the sawed length of Shelby tube to minimize sample disturbance.

Leachate Sampling

Leachate samples were collected from both the large and small impoundments. In addition, run-off samples were collected from the small impoundments.

The small scale above-ground impoundments provided a means of determining the worst case leachate quality without any dilution by groundwater or attenuation by soil reactions. As shown in Figure 7, leachate from the small impoundments drained by gravity to collection containers sunk into the ground. Run-off was collected from the surface through a gravel filter held in place by a coarse screen. Leachate samples were collected at regular intervals. Following each sample collection, the leachate collection reservoirs were drained and cleaned, in preparation for the next sample interval.

The large impoundments provided a means of assessing the quality of leachate that would evolve from an actual landfill operation. In this case,

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both dilution by groundwater and reactions with underlying soil could occur.

Although every attempt was made to sample according to the established schedule, inclement weather in some instances prevented sampling at the desired time. Therefore, the actual sample times are noted for each mixture.

At specified intervals, soil moisture samples were collected, using the "pressure-vacuum" lysimeters located at 2.4, 9.4, and 28.3 cm (6, 24, and 72 inches) beneath the test sites. (See Figure 9).

Field Test Results

The results of all strength, permeability, and leachates tests from the field impoundments are given in the appendices. The following discussion compares the behavior of the various sludge mixtures.

Strength

Table 6 lists the maximum compressive strengths measured in the laboratory and field mixtures. Of the carbide lime sludge mixtures, only Mix #2 (consisting of vacuum filtered sludge, fly ash, and fixative) developed a compressive strength $\geq$ 0.10 MPa (1.0 tons/ft^2) at all depths to provide an acceptable landfill material. Mix #1 (thickener underflow, fly ash, and fixative) developed a hard surface crust, but as shown in Figure 11, the underlying mixture was not capable of supporting any significant load. Mix #4, which contained sludge and fixative, but not fly ash, did not develop sufficient strength to provide an acceptable landfill, in fact, the initial strength of this mixture, ≈0.15 MPa (1.5 tons/ft^2), was significantly reduced during the test program, probably due to freeze thaw effects.

As shown in Figure 12, all but Mix #7 of the commercial lime sludge mixtures developed compressive strengths greater than the capacity of the in-situ vane shear device (.28 Mpa(3 tons/ft^2)). After less than 6 weeks of placement, Mix #7, the only commercial lime sludge/fly ash mixture which did not contain a fixative, exhibited little tendency toward cementitious proper-

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COMPARISON OF FIELD AND LABORATORY RESULTS OF PHYSICAL TESTING

TABLE 6

Process	Sample	Maximum Compressive Strength MPa (tons/ft²)					Minimum Permeability cm/s	
	Identification Location	Lab 60 days	Field (In-Situ) Initial	Field (In-Situ) Final	Field (Core) Initial	Field (Core) Final	Lab 60 days	Field (Core)
I	Mix 1 Pit 1	too soft (too soft)	<.01 (<.1)	0.15 (1.6)	too soft (too soft)	0.04 (0.4)	7.6×10^{-5}	3×10^{-5} (724 days)
II	Mix 2 Pit 2	.78 (8.2)	0.07 (.7)	> 0.28 (>3.0)	.02 (.2)	.10 (1.1)	2.9×10^{-6}	3.8×10^{-6} (661 days)
III	Mix 4 Pool 2	.88 (9.2)	0.06 (.6)	0.12 (1.2)	.01 (.1)	.03 (0.3)	4.5×10^{-7}	5.2×10^{-6} (664 days)
III	Mix 6 Pool 4	2.4 (25.1)	a (a)	a (a)	a (a)	a (a)	2.1×10^{-7}	a
III	Mix 7 Pool 10	.29 (3.0)	.12 (1.2)	0.27 (2.8)	.01 (.1)	.07 (0.8) (Brittle)	7.0×10^{-6}	too brittle
II	Mix 8 Pit 3	.69 (7.2)	.24 (c) (2.2)	>0.28 (b) (>3.0)	.09 (.9)	.14	4.1×10^{-6}	0.9×10^{-6} (464 days)
II	Mix 9 Pool 5	1.10 (11.6)	0.06 (.6)	>0.28 (b) (>3.0)	.03 (.3)	.26 (2.8)	5.7×10^{-7}	4.5×10^{-6} (59 days)
II	Mix 10 Pool 9	.52 (5.5)	> 0.28 (b) (3.2) (c)	>0.28 (b) (>3.0)	.31 (3.3)	.48 (5.0)	5×10^{-5}	1.5×10^{-6} (417 days)
II	Mix 11 Pit 5	.81 (8.5)	0.22 (c) (2.0)	>0.28 (b) (>3.0)	.10 (1.1)	0.15 (1.6)	2.9×10^{-6}	1.2×10^{-6} (466 days)
II	Mix 12 Pit 4	.68 (7.1)	0.26 (2.7)	>0.28 (b) (>3.0)	.10 (1.1)	0.20 (2.1)	9.2×10^{-6}	1.8×10^{-6} (452 days)

a) Not tested in field - spheres from "cement mixing" truck at start
b) Strength exceeded capacity of vane shear test device
c) No initial test (Measured at 48 days)

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Figure 11
IN-SITU STRENGTH - CARBIDE LIME SLUDGE MIXTURES

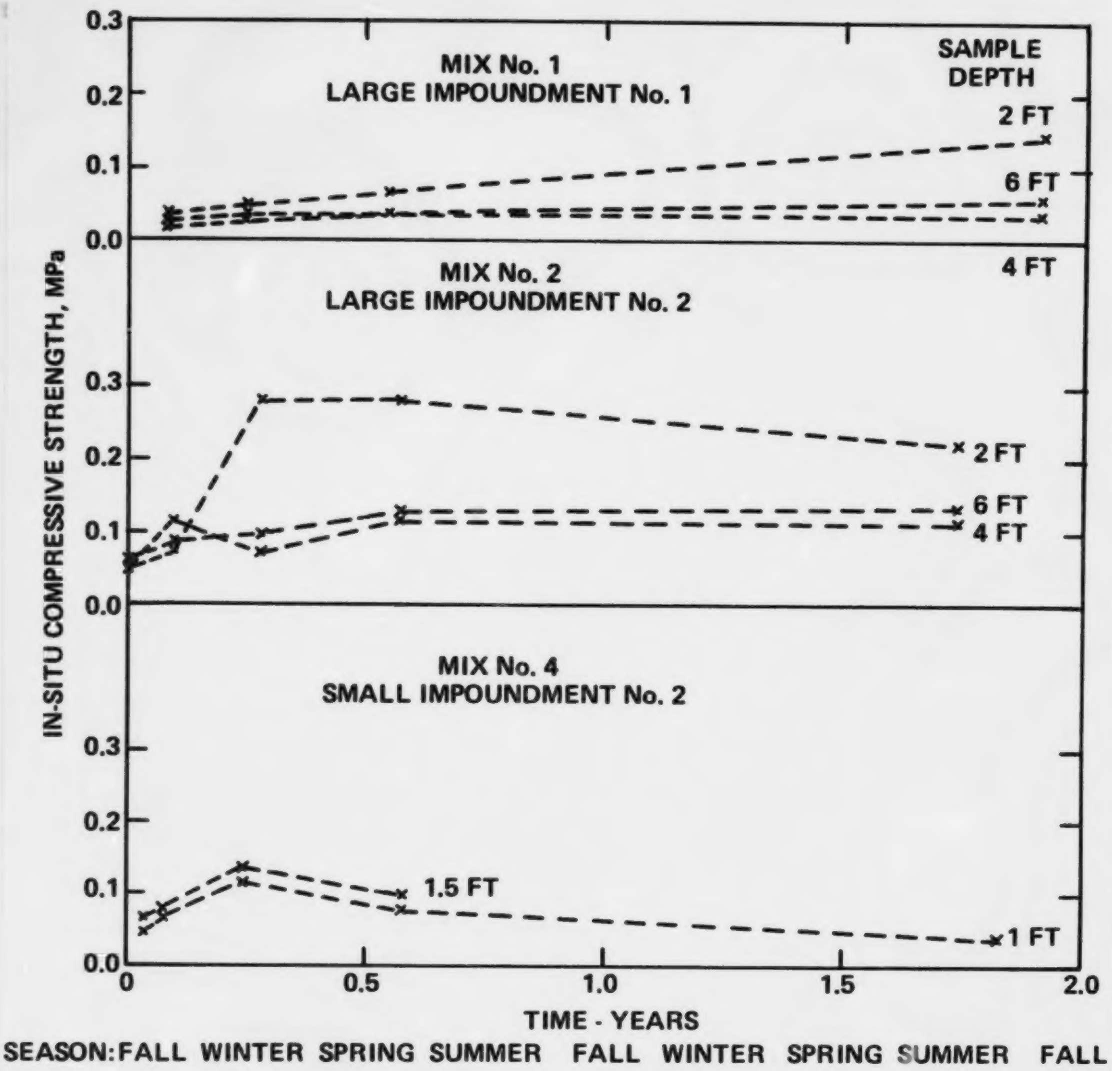

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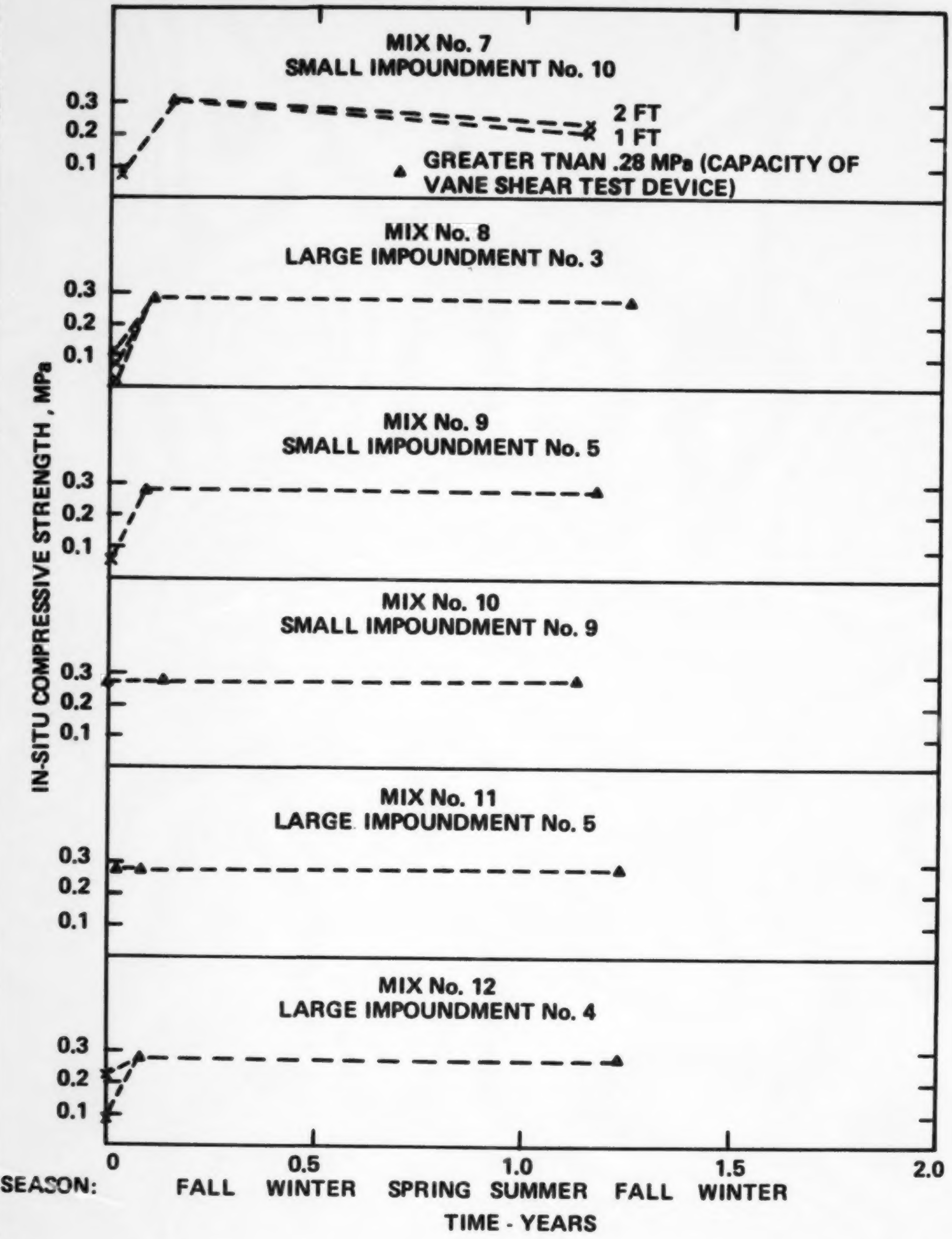
Figure 12

IN-SITU STRENGTH - COMMERCIAL LIME SLUDGE MIXTURES



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ties. The core samples collected for laboratory strength tests on this mix were extremely sensitive to disturbance and the samples were very friable and brittle. Although core samples collected from the other commercial lime mixtures all showed some degree of disturbance due to sampling, the compressive strength tests in the University of Louisville laboratory indicated that cementitious reactions had occurred to some extent in all the commercial lime sludge/fly ash/fixative mixtures (Mix #8 - #12). The highest strengths measured on core samples were from Mix #10 which used Portland cement as the fixative. This mixture formed a hard surface crust and appeared to be very resistant to weathering.

Because of the large degree of disturbance which occurred in the core samples from the high strength mixtures, additional in-situ plate load strength tests were run on two commercial lime mixtures (#11 and #12), to better define actual in place strength. The results of these tests are shown in Figures 13 and 14. In the test on Mix #12, in large impoundment #4, a total load of 1.34 MPa (14 tons/ft^2) caused a settlement of 3 cm (1.2 inches), indicating that this material would be capable of bearing significant foundation loads. Mix #11, in large impoundment #5, also showed significant load bearing capacity. Several cycles of loading were applied with loads up to 1.32 MPa (13.8 tons/ft^2); the net settlement after the loads were removed was 2.8 cm (1.1 inches). The behavior of Mix #11 under the plate load tests indicated that this material would be competent to bear very high foundation loads.

Mix #6, in small impoundment #4, was transported to the field site in a cement mix truck. This experiment was unsuccessful, resulting in the need to add large quantities of fly ash in order for the sludge material to discharge from the truck. The resulting large "snowballs" froze and desintegrated upon thawing. Consequently, physical tests were not performed on Mix #6.

In summary, Process II mixtures which contained rotary drum vacuum filter cake, flyash, and fixative provided the optimum combination of maximum compressive strength and low permeability for the environmentally safe im-

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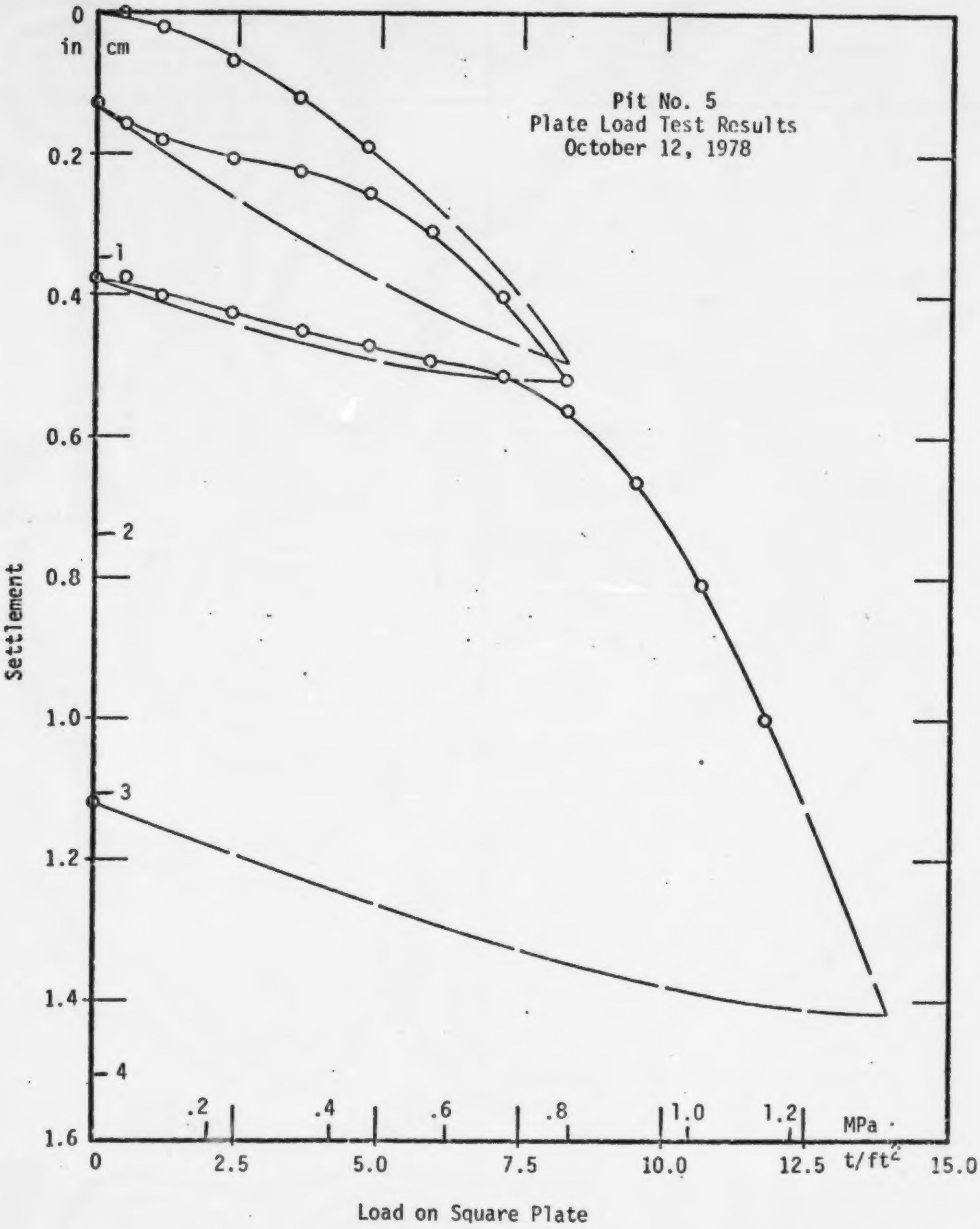

Figure-13 Plate Load Test Results for Pit 5. (Mix 11)

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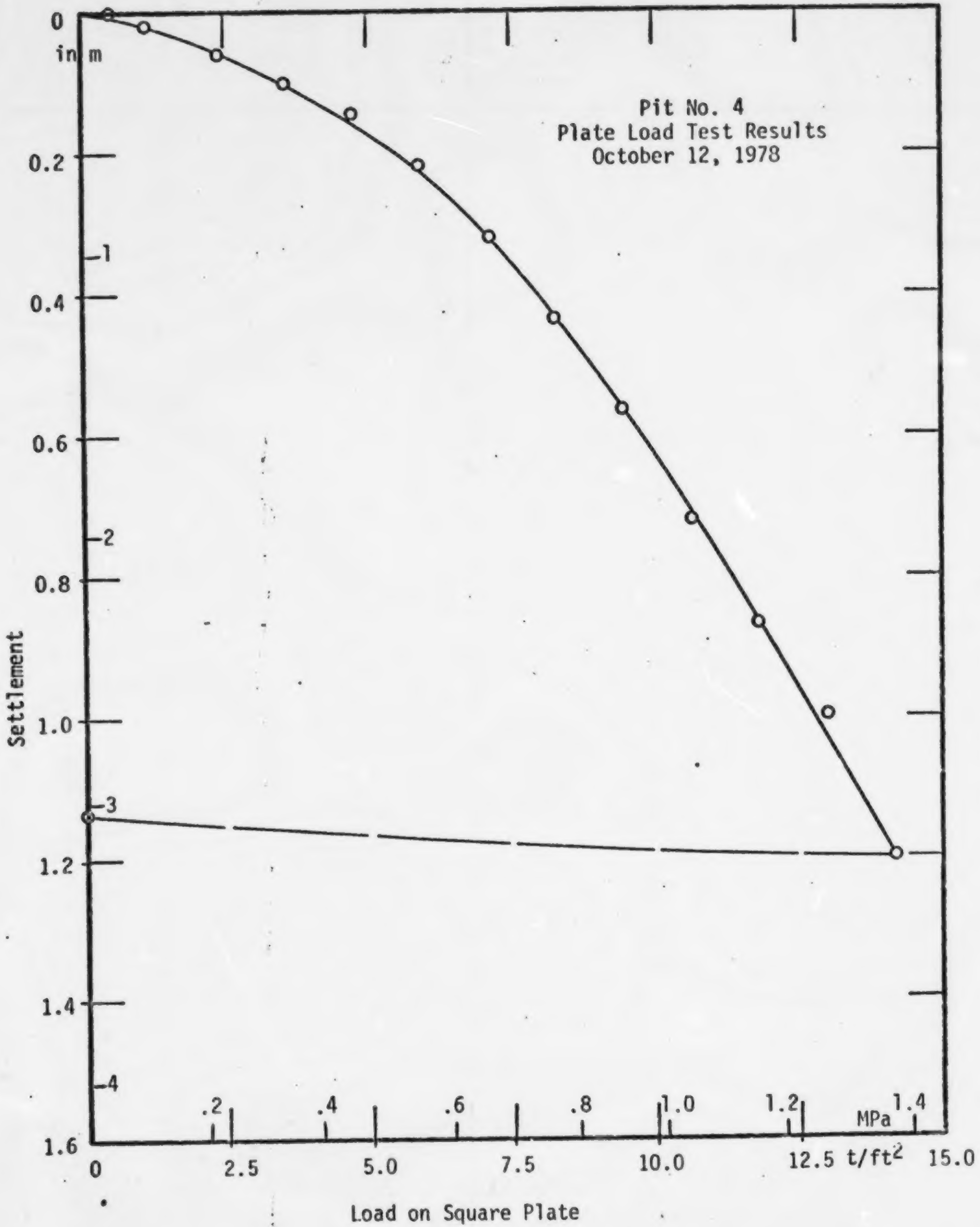

Figure - 14 Plate Load Test Results for Pit 4. (MIX 12)

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poundments of both carbide lime and commercial lime sludges as landfill.

Process I, utilizing thickener sludge at 24% solids, provided a mixture which was too soft for acceptable landfill. Mixtures compounded with filter press (high solids) sludge (Process III) proved to be brittle, gained little in compressive strength with time, and thus are not considered acceptable as landfill.

Permeability

The severe disturbance which occurred in the core samples made it difficult to obtain a valid sample for permeability testing from the field mixtures. However, for the core samples tested, it appears that the permeability of the field mixtures is within an order of magnitude of that measured on corresponding mixtures during the laboratory phase. Proper compaction during placement of the field mixtures is a strong factor in the reduction of permeability. In some mixtures (particularly those in the above-ground pools) where compactions was not adequate, the in-situ mass permeability may be higher than measured on the core samples. In an actual full-scale landfill operation, conventional compaction equipment would be used to assure that a specified density is obtained.

As with the laboratory test samples, an inverse relationship between permeability and unconfined compressive strength was noted for the core samples. (Figure 15)

Leachate Analysis

Major Constituents--

Mix #1, which consisted of carbide lime sludge thickener underflow, fly ash, and lime, (Process I mixture), produced the poorest quality leachates throughout the field study. This mixture was placed at $\approx$35 - 50% solids. The leachates collected from the small above-ground impoundments contained between 1000 - 5000 PPM dissolved solids, with an average of approximately

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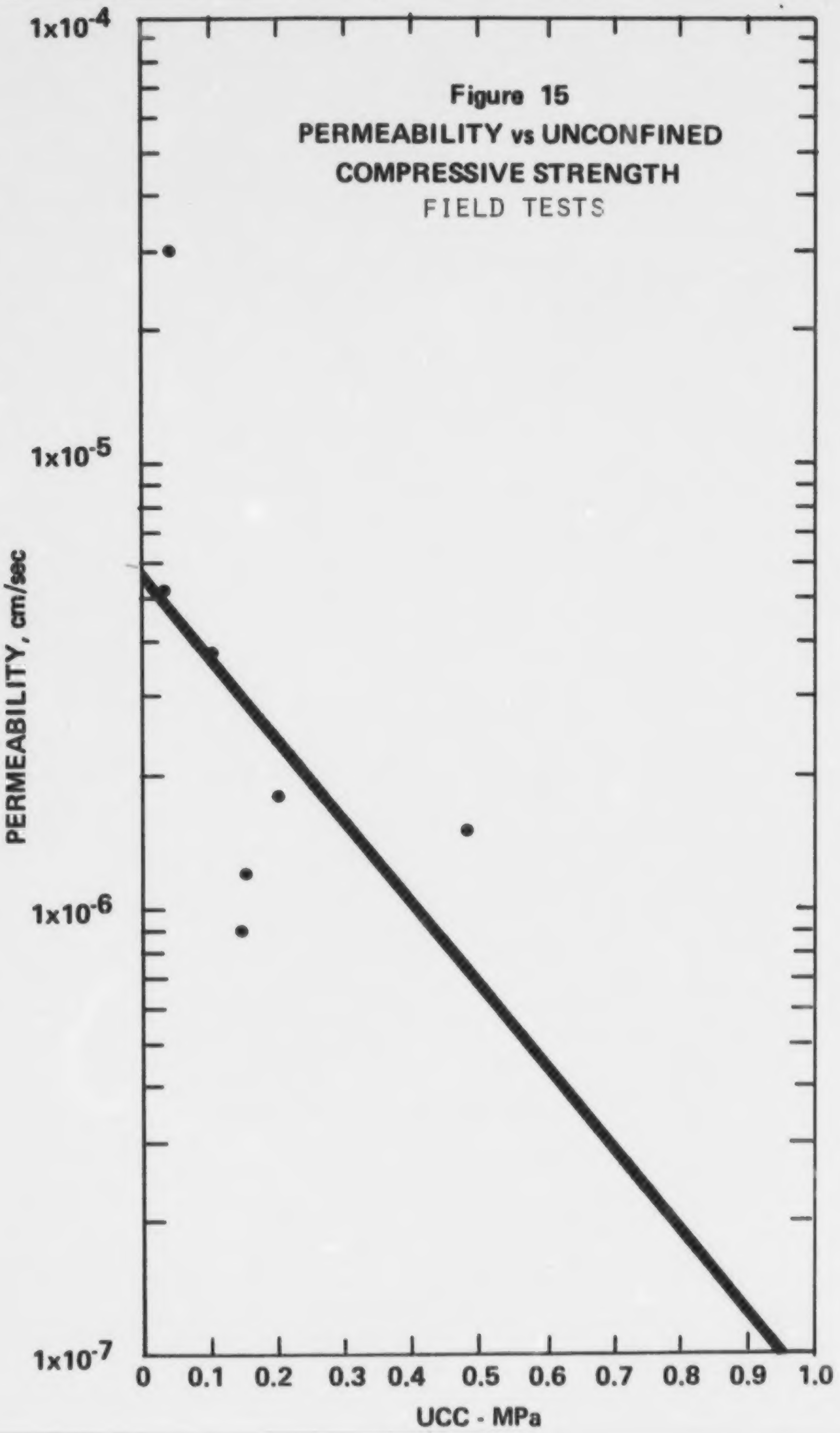

Figure 15
PERMEABILITY vs UNCONFINED COMPRESSIVE STRENGTH
FIELD TESTS

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3000 PPM. (See Figure 16) The soil moisture samples collected beneath the large in-ground impoundments containing Mix #1 showed that some contaminants were leaching from the sludge mixture into the underlying soil. Initial soil moisture samples collected 15.2 cm (6 inches) below the large impoundment contained approximately 4000 PPM of dissolved solids, similar to the leachates from the small impoundment. As shown in Figure 16, a gradual decrease in dissolved solids concentration occurred in the soil moisture samples with time and depth, indicating that some attenuation of contaminant impact on groundwater was provided by the underlying soil.

Process II mixtures consisted of a sludge dewatered to a solids content obtainable by rotary drum vacuum filtration with fly ash and fixative in various proportions. Due to the superior filtration properties of commercial lime sludges, these mixtures were placed at higher solids contents than the Process II carbide lime sludge mixture. Commercial lime sludge mixtures varied from 58 - 70% solids, depending on fly ash addition, while the single carbide lime sludge Process II mixture (#2) was placed at approximately 54% solids. Solids content at placement had a strong impact on the ability to compact the mixtures; and, subsequently, on the permeability of the test site.

The quantity of leachates collected from the small impoundments containing Process II mixtures was significantly lower than from the Process I mix. In general, no leachate samples were available from the small above-ground impoundments containing Process II mixtures until 2 - 3 months after placement; and, in several cases, no leachate was produced during the test period.

Leachate quality varied among the Process II mixtures due to the ratio of fly ash: sludge, type of fixative, and the degree of compaction achieved during initial placement. In many cases, it is difficult to differentiate these effects. However, a comparison between Mixes #8, #9, and #11 gives an indication of the trend. All three mixtures were made with commericial lime sludge, fly ash, and lime as a fixative; Mix #8 contained a fly ash: sluge ratio of 0.5:1.0, Mix #11 a ratio of 1.0:1.0, and Mix #9 was 1.5:1.0. Figures 17-19 compare leachates from these mixtures. The additional fly ash in Mix #11 allowed greater compaction than Mix #8, enhanced fixation, and

LEACHATE AND RUNOFF SAMPLES - MIX NO. 1

TOTAL DISSOLVED SOLIDS (TDS)

24% CARBIDE LIME SLUDGE + 1 PART FLY ASH: 1 PART DRY SOLIDS + 5% CARBIDE LIME

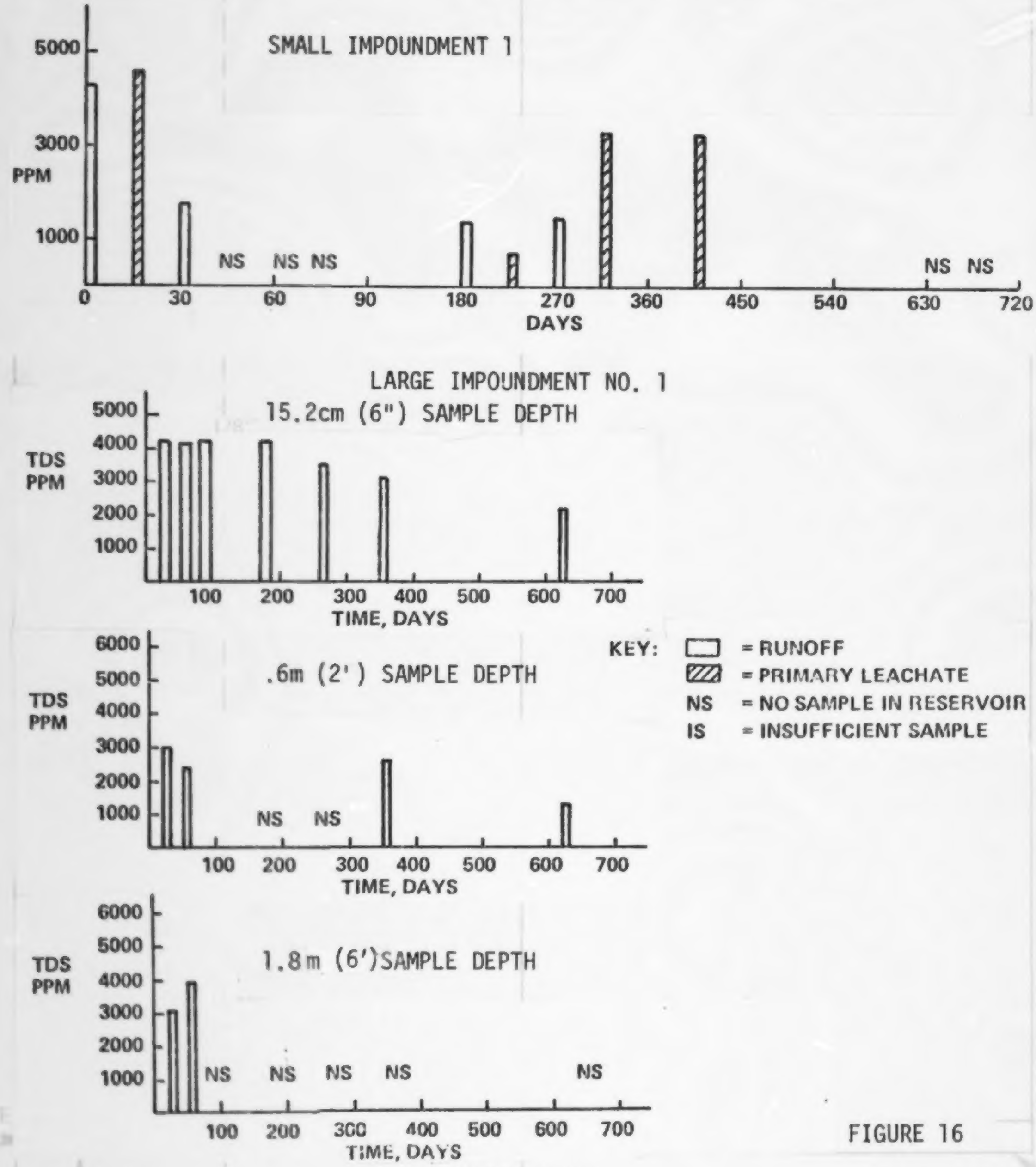

FIGURE 16

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TOTAL DISSOLVED SOLIDS (TDS) - MIX NO. 8

50% COMMERCIAL LIME SLUDGE + 0.5 PARTS FLY ASH: 1 PART DRY SOLIDS + 3% CaO

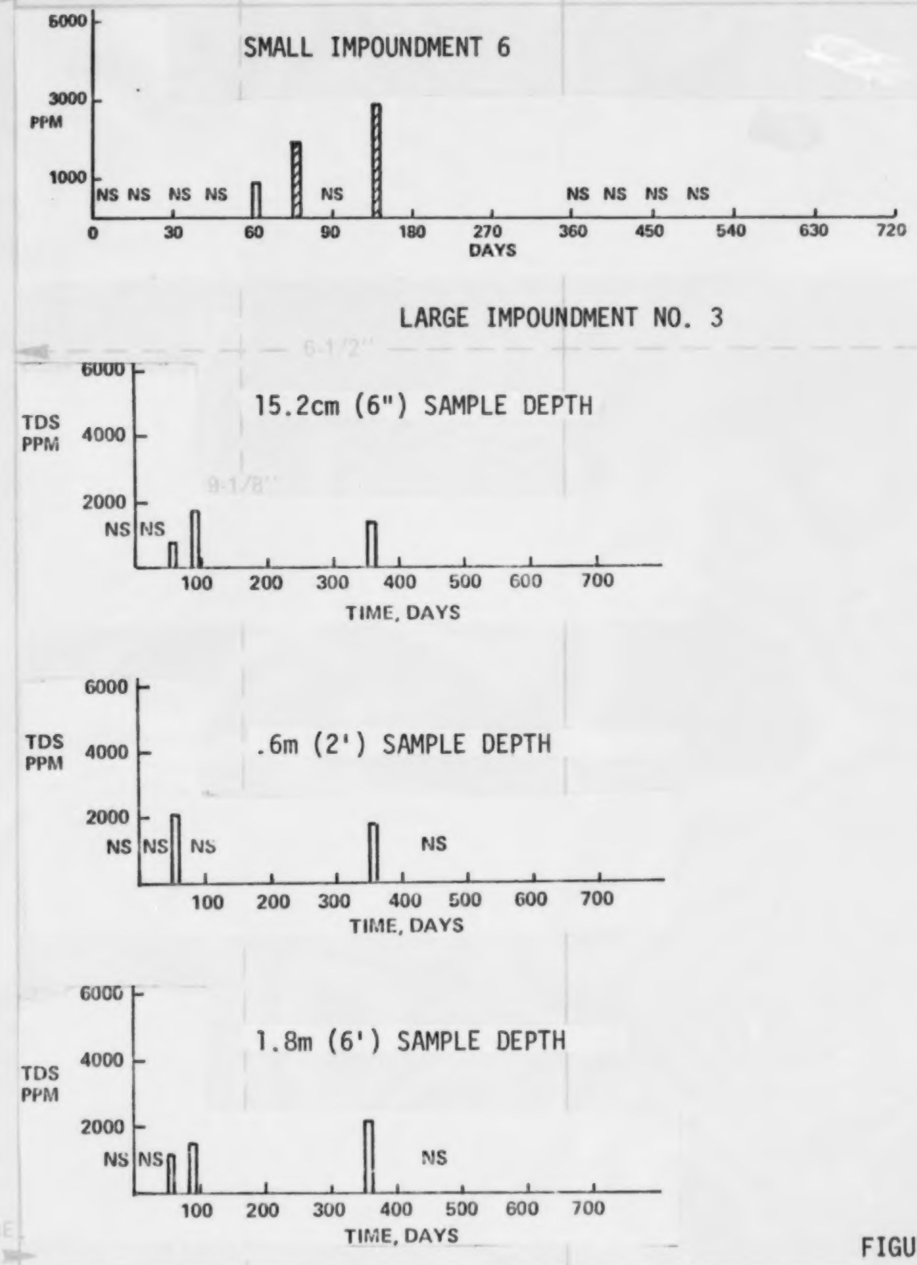

FIGURE 17A

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CALCIUM - MIX NO. 8

LARGE IMPOUNDMENT NO. 3

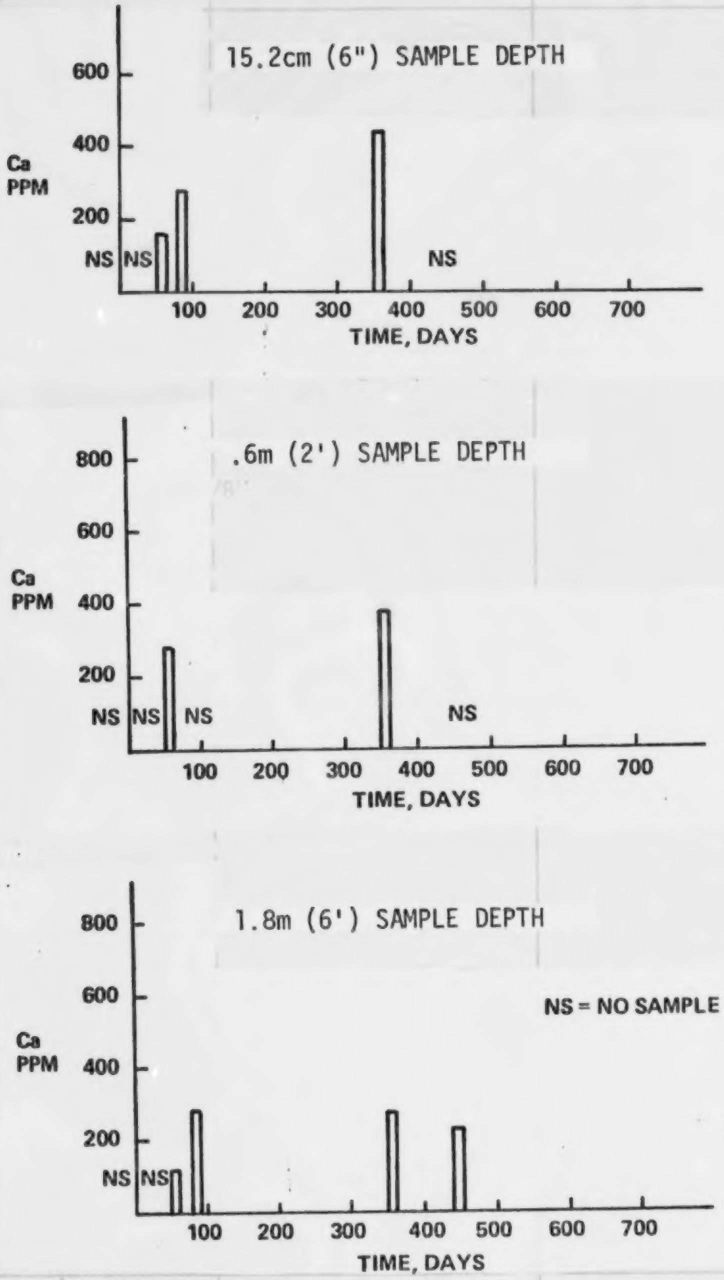

FIGURE 17B

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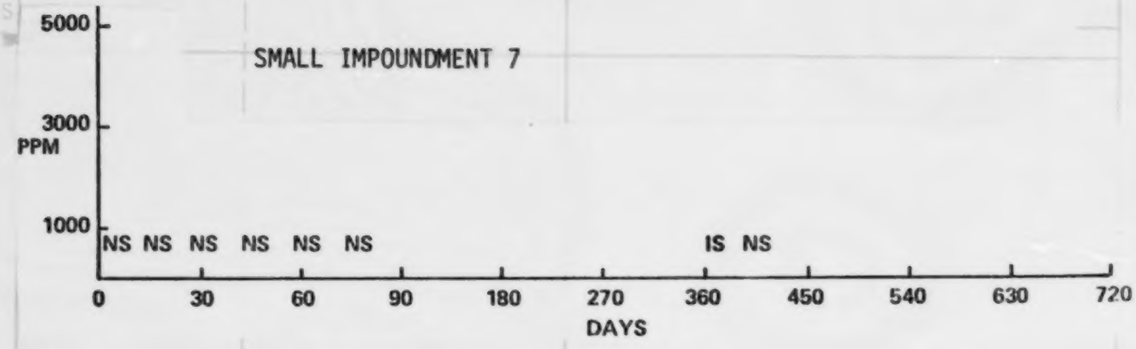
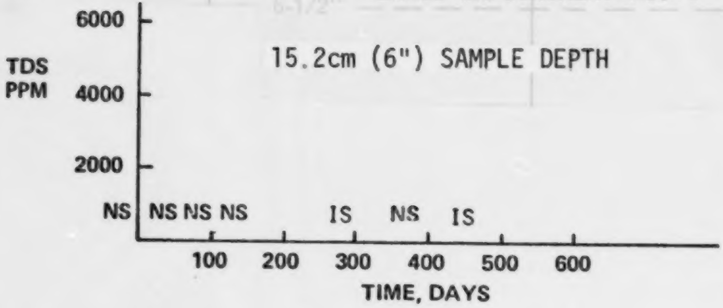
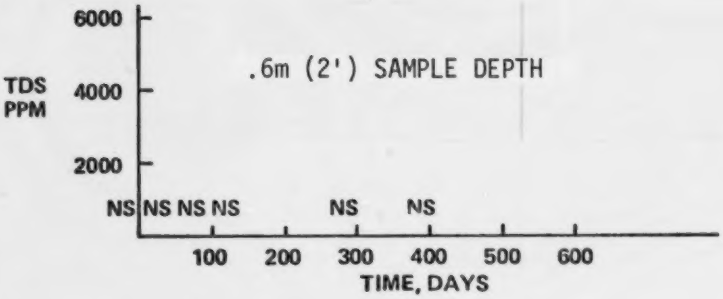
TOTAL DISSOLVED SOLIDS (TDS) - MIX NO. 11

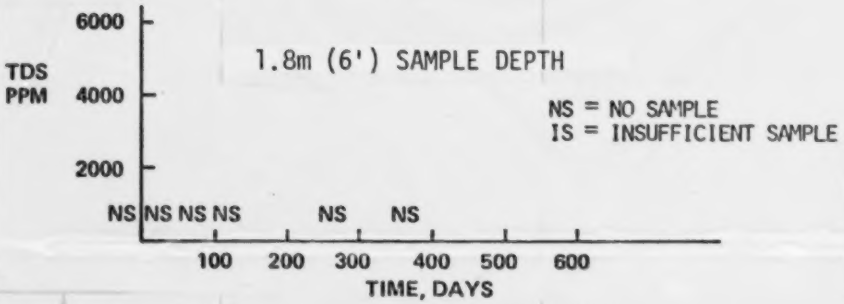
50% COMMERCIAL LIME SLUDGE + 1 PART FLY ASH: 1 PART DRY SOLIDS + 3% CaO



LARGE IMPOUNDMENT NO. 5







NS = NO SAMPLE
IS = INSUFFICIENT SAMPLE

FIGURE 18A

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CALCIUM - MIX NO. 11

LARGE IMPOUNDMENT NO. 5

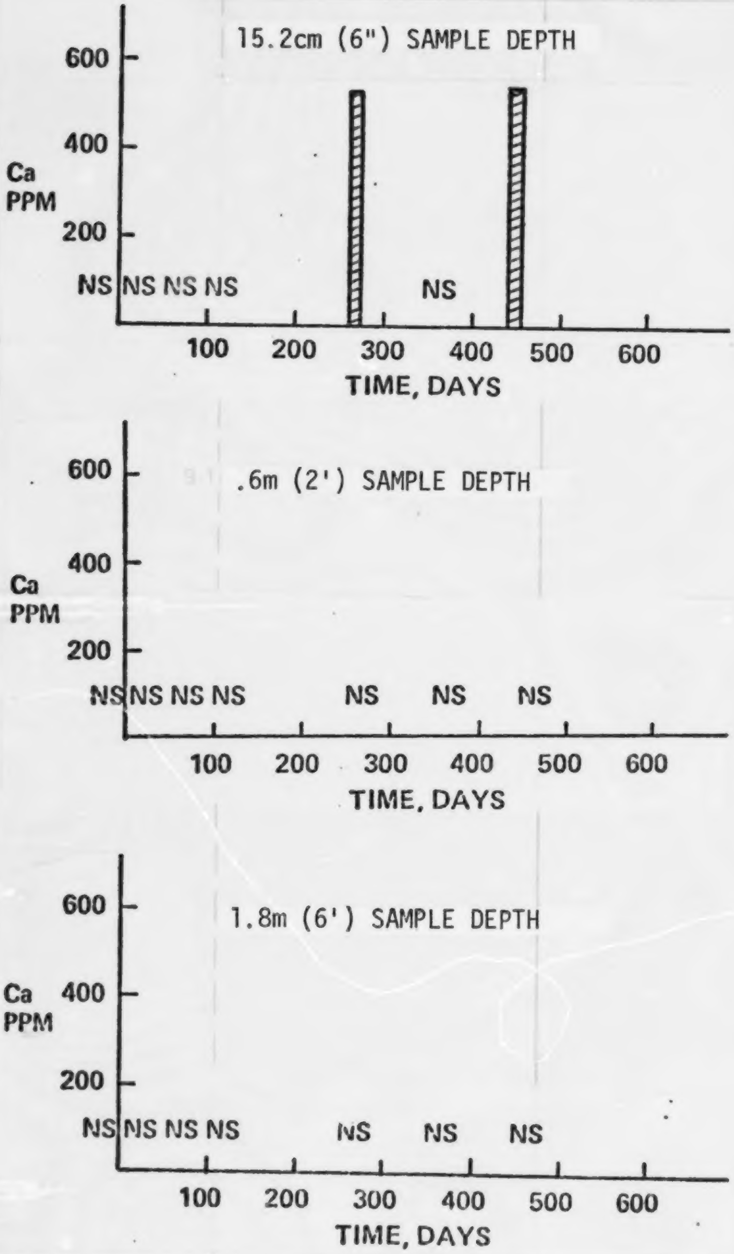

FIGURE 18B

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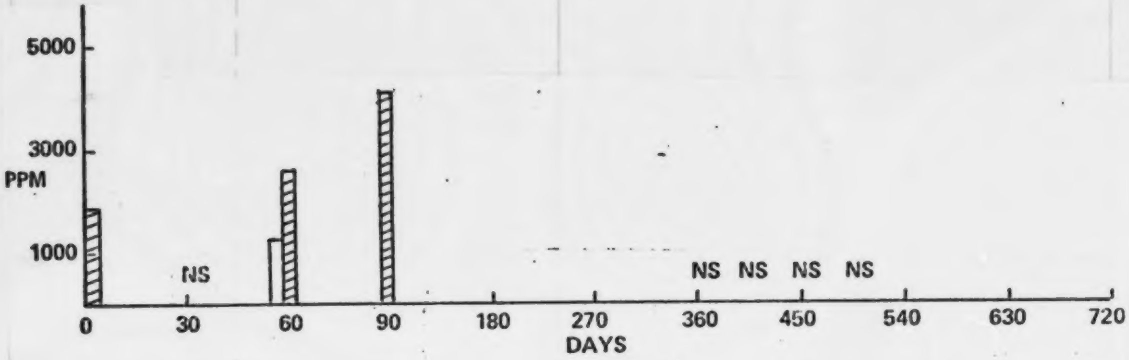
LEACHATE AND RUNOFF SAMPLES - MIX NO. 9

50% COMMERCIAL LIME SLUDGE 1.5 PARTS FLY ASH: 1 PART DRY SOLIDS + 3% CaO

TOTAL DISSOLVED SOLIDS (TDS)



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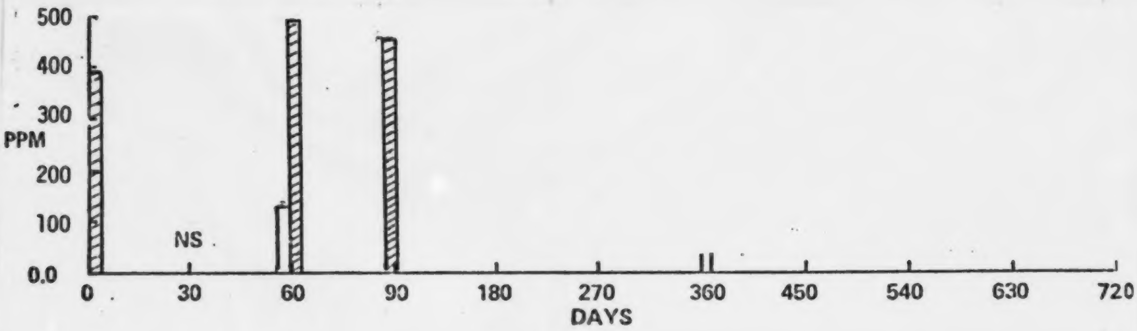
CALCIUM



KEY: ☐ = RUNOFF
▨ = PRIMARY LEACHATE
NS = NO SAMPLE IN RESERVOIR

FIGURE 19

BOTTOM OF IMAGE AREA OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
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resulted in a mixture with lower quantities of leachate generation. In Mix #9, however, concentrations of dissolved solids and other contaminants were higher than those measured in either Mix #8 or #11. Thus, there appears to be an optimum proportion of fly ash (1:1 fly ash/sludge in this case) beyond which leachate quality begins to degrade.

The Process II carbide lime sludge mixture (#2) contained vacuum filter sludge cake, fly ash, and carbide lime fixative. Leachates were available from the small above-ground impoundment 180 days after placement. The initial leachate samples contained ≈5000 PPM dissolved solids; subsequent leachate samples contained less than 1000 PPM. (Figure 20) Soil moisture samples from beneath the in-ground impoundment containing Mix #2 showed a release of dissolved solids to the groundwater slightly lower than from the Process I carbide lime sludge (Mix #1).

Two Process III mixtures were prepared with carbide lime sludge and one with commercial lime sludge. Unfortunately, problems with the sampling equipment prevented the collection of leachate from the commercial lime sludge Process III mixture. The two carbide lime sludge mixtures were: Mix #4, filter press cake, and Mix #6, filter press cake, fly ash, and fixative. Total dissolved solids concentrations in the leachates from Mixes #4 and #6 are shown in Figure 21.

Trace Elements--

Trends in trace element concentrations between various sludge mixtures were more difficult to discern than those of major constituents due to the lower accuracy inherent in the analysis of these elements in the parts per-billion range. In many cases, trace element concentrations were below detectable limits or below background levels (as determined by rainwater and groundwater analysis).

Mix #1, the Process I carbide lime sludge mixture produced the leachates with the highest levels of trace contaminants during the study. Figure 22 compares the concentration of one trace metal, arsenic, in leachates from Mix #1, and two Process II mixtures, Mix 8 and Mix 11. Similarly, soil moisture samples from beneath the large impoundments for these same three mix-

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LEACHATE AND RUNOFF SAMPLES - MIX NO. 2
TOTAL DISSOLVED SOLIDS (TDS)
(FLY ASH/SLUDGE 1:1, 5% CARBIDE LIME FIXATIVE) 50% SOLIDS MIXTURE

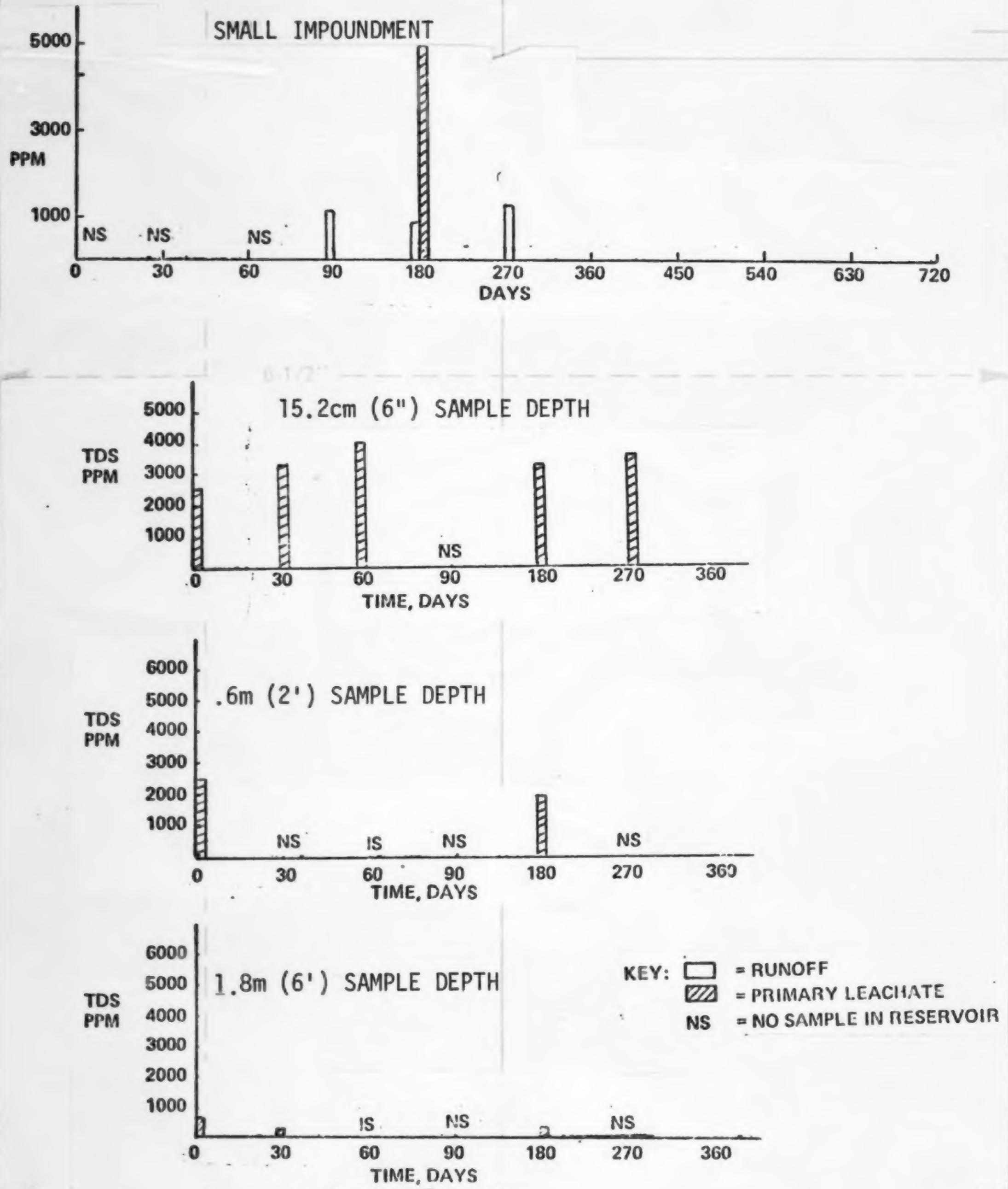

FIGURE 20

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LEACHATE AND RUNOFF SAMPLES - MIX 4 & 6

TOTAL DISSOLVED SOLIDS (TDS)

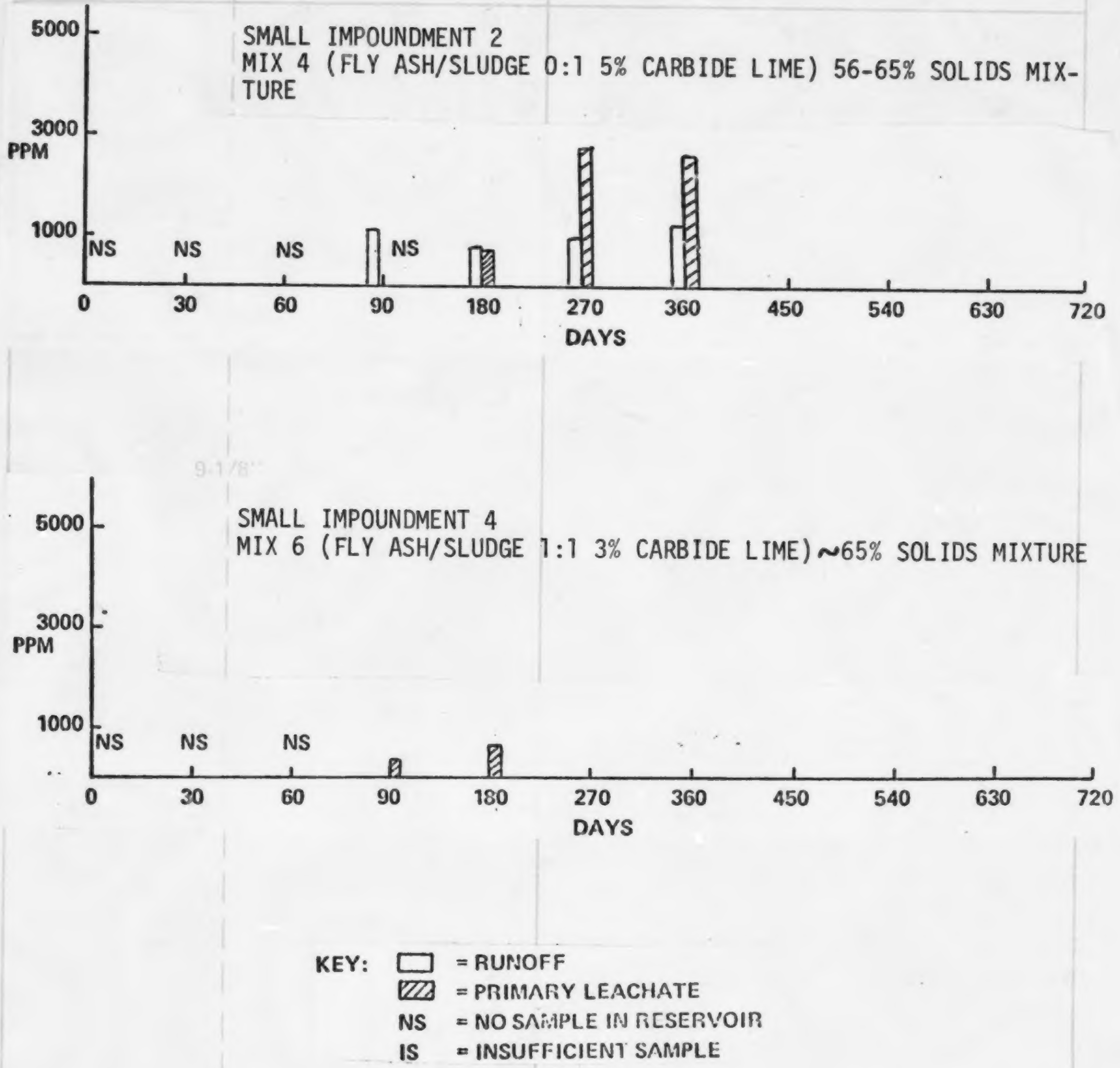

FIGURE 21

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LEACHATE AND RUNOFF SAMPLES
Mix 1, 8, & 11
ARSENIC (RCRA LIMIT 50 PPM)

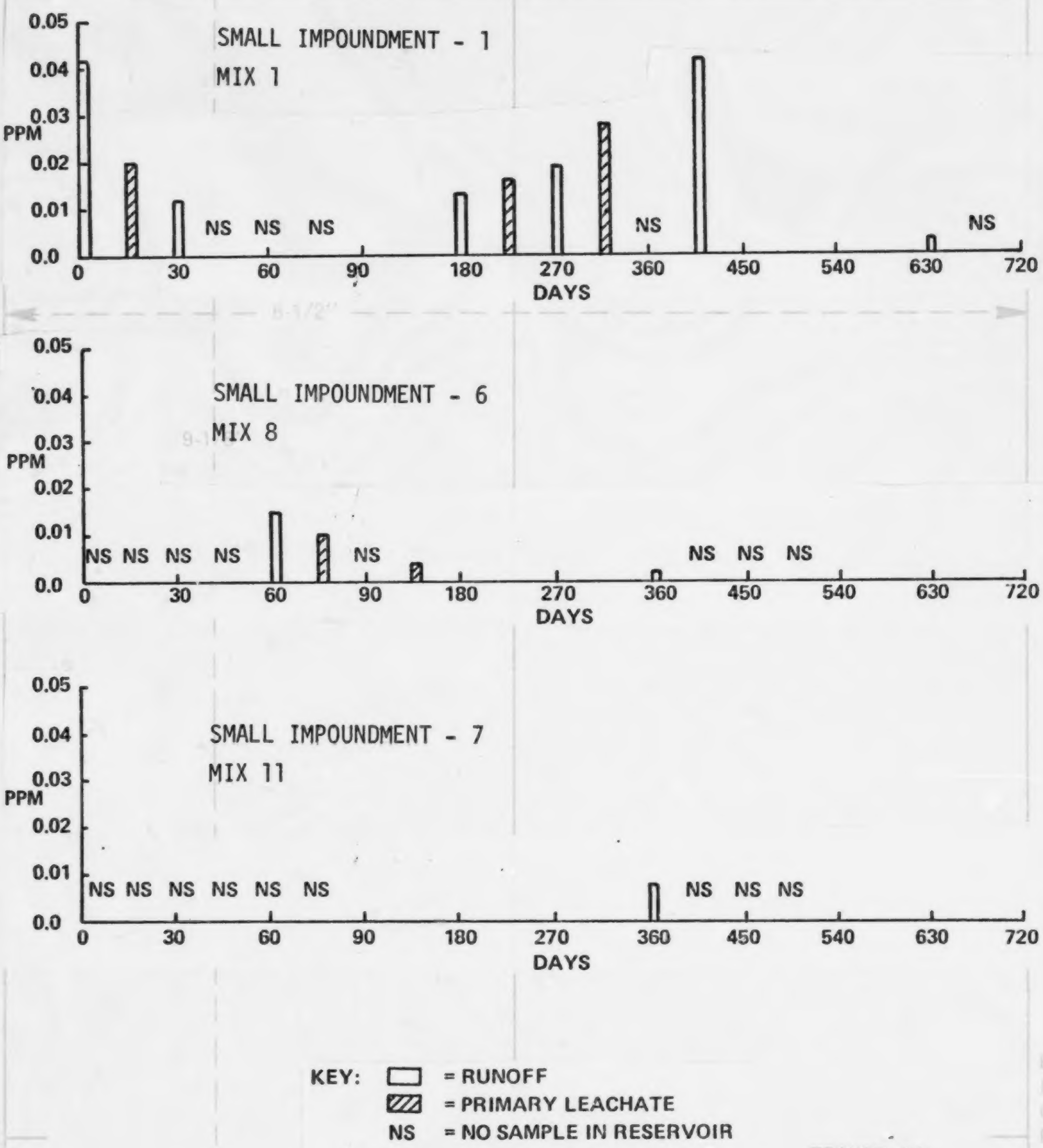

FIGURE 22

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tures contained the selenium concentrations shown in Figure 23.

It is important to note that the concentration of trace elements in all leachates and soil moisture samples collected in this study were below those established under RCRA for defining hazardous wastes. Thus, on the basis of toxicity, all of the sludge mixtures tested would be designated non-hazardous.

Summary of Leachate Analysis Results--

Based on an evaluation of both major and trace contaminants measured in the leachate tests, the following results were evident:

1. Leachate generation decreased with time for those mixtures which were designated Process II and Process III. Leachate quality improved with increasing dryness up to an optimum mixture dryness at placement, beyond which the material became brittle, permeability increased, and thus, leachate generation increased.

2. The quantity of leachate from the low solids Process I mixture decreased initially, then remained fairly constant during the test period. This mixture produced the poorest quality leachates of the field study.

3. Soil moisture quality beneath the large impoundments containing Process II mixtures increased with time, indicating a reduction in leachate generation. Also, quality increased with depth below the impoundment, indicating some physical filtering or chemical ion exchange reaction with the surrounding soil.

4. The concentration of trace elements found in the collected leachate and soil moisture samples were below RCRA limits throughout the testing.

Appendix B contains the complete data base of all leachate samples collected from the field test sites.

SELENIUM - MIX NO. 1

LARGE IMPOUNDMENT NO. 1

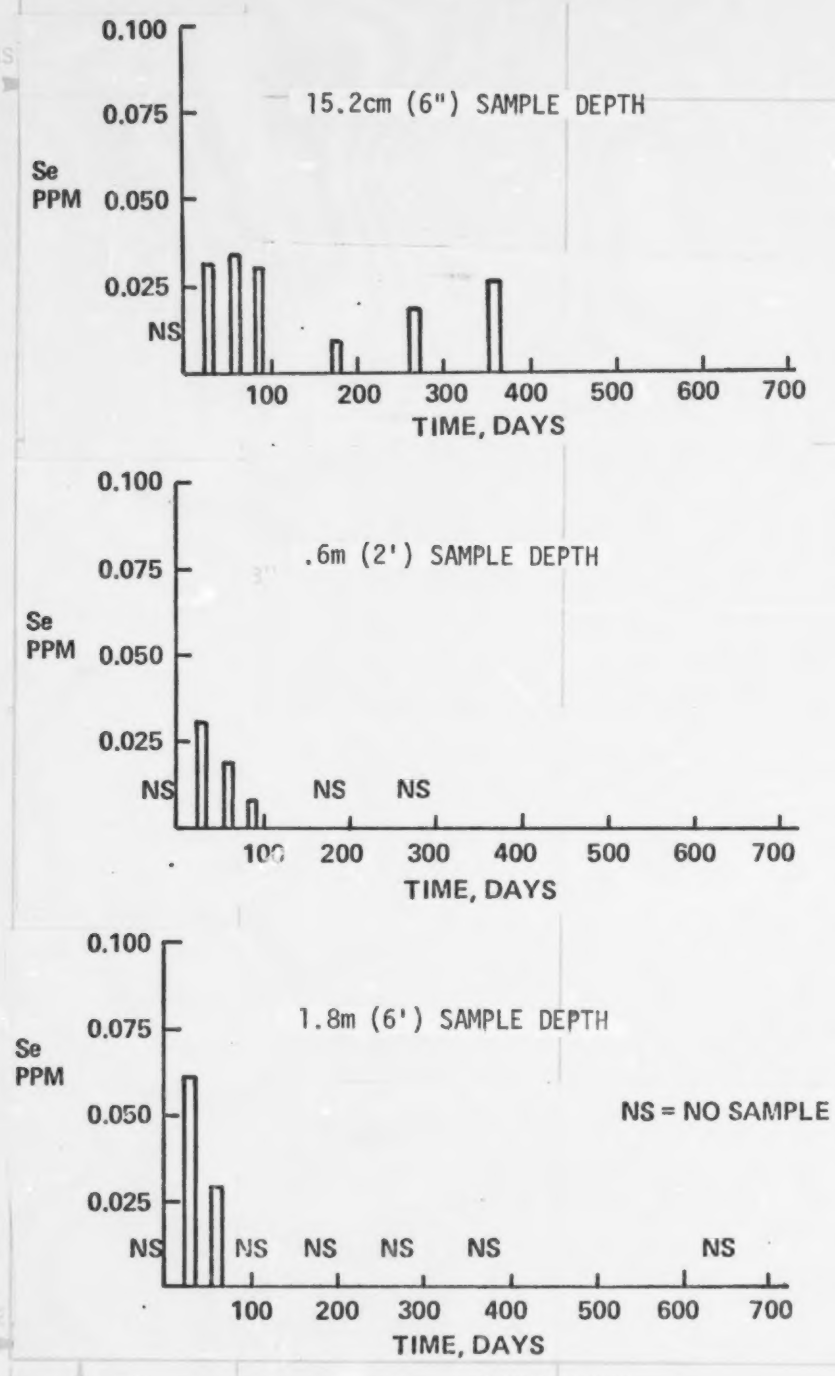

FIGURE 23A

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SELENIUM- MIX NO. 8
LARGE IMPOUNDMENT NO. 3

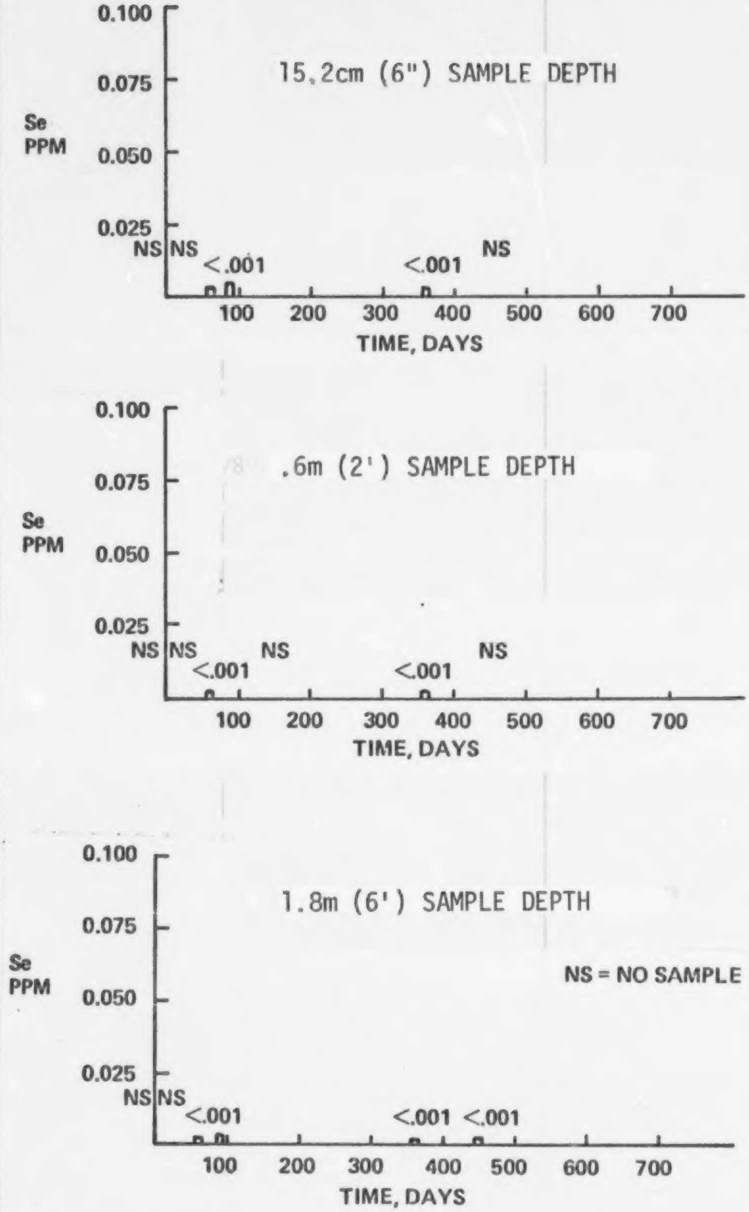

FIGURE 23B

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SELENIUM - MIX NO. 11

LARGE IMPOUNDMENT NO. 5

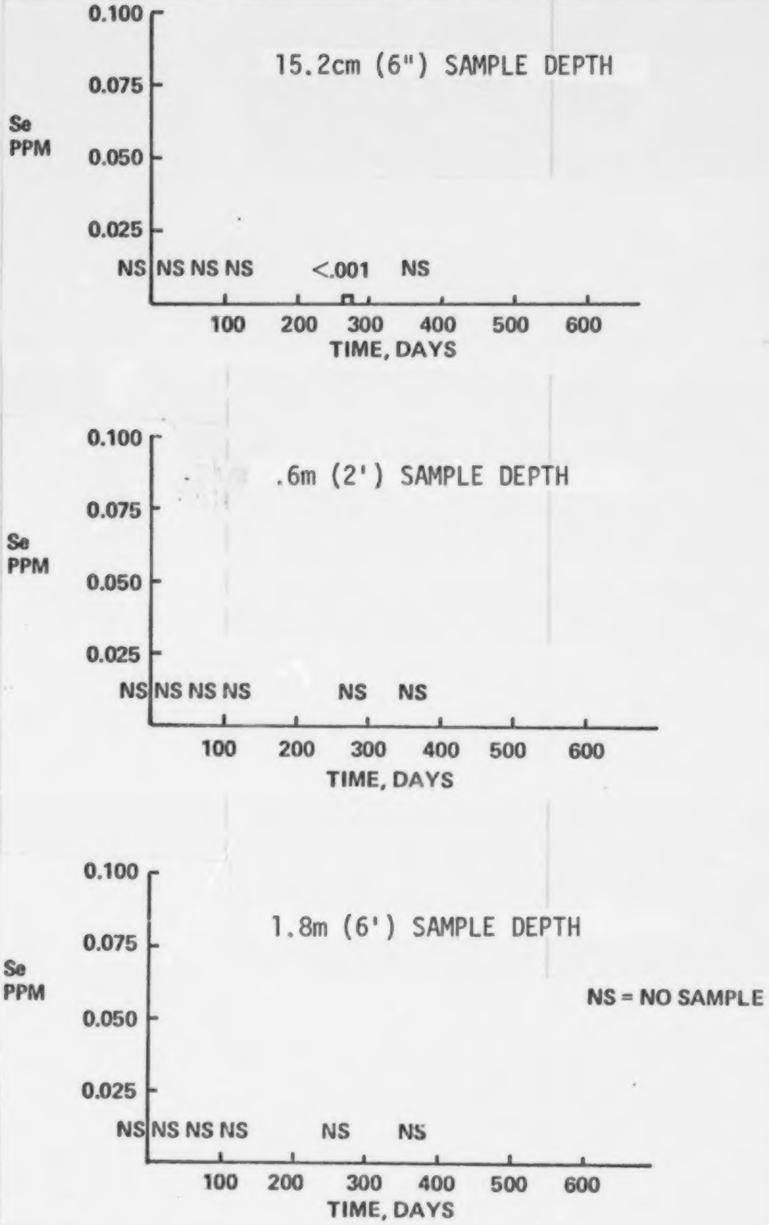

FIGURE 23C

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SECTION 7

TRANSPORTATION AND HANDLING PROPERTIES

OVERVIEW

The properties of the various mixtures tested were highly dependent on moisture content. Modifications were necessary to several sections of the process equipment during the program to improve material handling. These modifications and other items of interest are discussed below.

FILTER PRESS

The filter press was an effective dewatering device; however, it was necessary to have an attendant available at all times to assure that cake removal was complete. No solution was found to assure complete removal continuously other than by manual force. Although the filter press provided flexibility in the preparation of sludges with desired moisture contents, it appears that a rotary vacuum filter such as presently used at LG&E is a simpler, more reliable dewatering device in terms of unsupervised operation.

FILTER CAKE FEED SYSTEM

Initially, for Phase I, the filter cake hopper design was a lazy vee with one straight side and one sloped side.

When the filter press cake dropped into the rapidly narrowing hopper, bridging occurred over the discharge opening and it was often necessary to push the cake manually down into the feed screw.

Addition of bin vibrators and a change to the profile of the hopper slope provided some improvement. The hopper was modified to change the slope from a lazy vee configuration to a shelf and slot. This design prevented bridging, but it was still necessary to manually feed the filter cake into the 6" screw conveyor.

For Phase II, the surge bin was modified to feed into a four flite screw conveyor, a so-called "live Bottom" bin. This system kept the sludge material in a semi-fluid state and moved it easily out of the hopper without assistance. Phase II was completed with no further filter cake hopper problems.

MIXER

During Phase I, sludge, fly ash, and fixative were all fed to the disc mill by a series of screw conveyors. Problems were encountered due to bridging in the feed screw when dry fly ash contacted the sticky, plastic sludge. It was often necessary to force the materials into the feed screw by a wooden paddle. Following Phase I, a modification to the mill feed system was made and the initial contact point for the dry and wet materials was moved as close to the entrance of the mill as possible. This modification was an improvement, but plugging of the mill entrance still occurred occasionally.

The final modification was the installation of a pneumatic fly ash transport system which fed the fly ash through the hollow core of the mill feed screw directly to the mixer internal surface. The sludge and fixative were still fed using the screw conveyor. By moving the contact point of the wet and dry materials into the shearing surface, the plugging and bridging problems were solved and mixer operation improved dramatically.

ALTERNATE MIXING PROCESS

During Phase I operations, when serious difficulties were being encountered with the feed of materials to the mixer, it was decided to try using a cement mixing truck to prepare Mix #6, with mixing to be accomplished during transportation to the pond. During the test, simultaneous feeding of fly ash and sludge cake to the cement truck was as difficult as previous feeding to the Bauer mixer.

The material plugged the cement truck inlet; it was finally necessary to alternate feed of filter cake and fly ash. Unloading the truck was also difficult. The material was sticky and would not discharge from the truck until significant quantities of additional fly ash were added to produce a drier mix. Even with the addition of fly ash, the material had to be pushed and prodded down the discharge chute. The results of the operation indicated that the cement mixing truck was not suitable for mixing or transporting stabilized sludge materials.

TRANSPORTATION

The majority of the sludge mixtures were moved by open truck from the pilot plant to the disposal sites-- approximately 10 miles. In order to avoid spillage problems, the truck tailgates were sealed with gaskets. Due to the short distance and quick turnaround, no dust problems were encountered, but it is likely that commercial operation would require some form of dust cover for the trucks if the transport time is long.

MISCELLANEOUS

Cold weather operation caused two problems that were resolved by heat tracing and insulation:

1. Slurry pumps and piping froze.
2. Compressed air actuated pump and valves froze.

In summary, the pilot plant experiences demonstrated that the sludge, fly ash and fixative could be effectively metered, mixed and transported. However, design of equipment must take into account the sticky, plastic, pseudo-thixotropic properties of the sludge and provide a positive motive force throughout the disposal equipment train to prevent plugging and bridging material.

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APPENDICES

DISCUSSION OF APPENDICES

The appendices of this report consist of ducuments prepared at the completion of various phases of the project.

Laboratory studies on compressive strengths and permeability of 62 mixtures of dewatered carbide or commercial lime FGD sludges and fly ash precede the field studies. Results from these studies were helpful in the selection of the mixtures to be included in the ten field impoundments (see Appendix A).

The field monitoring program planned to cover one year on both carbide and commercial lime sludge-fly ash impoundments covered up to 660 days for carbide lime impoundments and up to 480 days on the commercial lime sites.

Leachate analysis (Appendix B) indicated that the concentration of significant elements have generally decreased with time.

The carbide lime and commercial lime field tests sections (Appendices C and D) cover the assessment of scrubber steady-state operation and the construction of two types of field impoundments. The fifteen impoundments were filled with dewatered and/or stabilized mixtures of carbide lime or commercial lime FGD sludges and fly ash. Complete data on preparation of the mixtures as well as analytical support data accumulated during transition periods between scrubber operating tests is also included.

Preliminary in situ evaluations indicate that most sites have developed compressive strengths significantly greater than the minimum required for recrational landfill. Estimates of maximum in situ permeability based on laboratory tests performed on disturbed samples indicate that most sites have properties similar to those found for silty clay (Appendix E).

A study of groundwater hydrology in the region of the disposal sites is included as Appendix F.

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Appendix A

Laboratory Tests

Strength, Permeability, Leachate, Freeze-Thaw

Introduction

The attached report was issued in January, 1977 and describes the selection process by which the ten mixtures included in the field impoundments were selected from an original 59 mixtures and three supplementary mixes. On the basis of compressive strength data obtained on the original mixtures, the number of mixtures for further evaluation was reduced to 24.

Laboratory falling head permeabilities were determined on these mixtures and the leachate analyzed for selected trace elements. From the results of these tests, the mixtures for field impoundment were selected. Of the original twelve mixtures, the selected ten were prepared and impounded in the field.

Freeze-thaw testing, carried out on potentially stabilized carbide lime-fly ash mixes late in 1976, was also utilized in the selection process.

Table A-1

Mixtures to be Evaluated in Laboratory Program

	Sludge		Fixative		60-Day Compressive Strength Tons/ft^2	Fly Ash Ratio	Permeability cm/sec
	Type	Percent Solids	Type	(%) Amount			
I	Carbide lime	24%	Carbide lime Additive	5	too soft	1:1	(P1) $7.6\mathrm{x}10^{-5}$
				25	too soft		(P2) $8.5\mathrm{x}10^{-5}$
	Carbide lime	24%	CaO	5	too soft	1:1	
				20	too soft		
II	Carbide lime	42%	Carbide lime Additive	5	8.21	1:1	(P3) $2.9\mathrm{x}10^{-6}$
				10	9.23		
				15	5.17		(P4) $7.7\mathrm{x}10^{-7}$
III	Carbide lime	42%	CaO	3	6.83	1:1	
				5	9.05		(P5) $1.1\mathrm{x}10^{-6}$
				10	9.08		
	Carbide lime	55%	CaO	5	4.17	0:1	
	Carbide lime	55%	CaO	3	33.95	1:1	
				5	25.38		
				10	38.91		
IV	Carbide lime	55%	Carbide lime Additive	5	9.20	0:1	(P9) $4.5\mathrm{x}10^{-7}$
				0			(P8) $3.9\mathrm{x}10^{-6}$
V VI	Carbide lime	55%	Carbide lime Additive	0	14.63	1:1	(P6) $5.7\mathrm{x}10^{-7}$
				3	25.14		(P7) $2.1\mathrm{x}10^{-7}$
				5	49.57		
				10	55.10		
	Commercial lime	50%	Portland Cement	3	1.52	0.5:1	(P11) $1.4\mathrm{x}10^{-5}$
				5	1.56		(P17) $3.5\mathrm{x}10^{-5}$
				10	5.88		(P12) $2.9\mathrm{x}10^{-6}$
X	Commercial lime	50%	Portland Cement	3	5.46	1:1	(P18) $5\mathrm{x}10^{-5}$
				5	2.77		(P19) $1.1\mathrm{x}10^{-5}$
				10	12.00		
	Commercial lime	50%	Portland Cement	3	6.68	1.5:1	(P13) $2.5\mathrm{x}10^{-6}$
				5	10.01		
				10	19.32		
VIII	Commercial lime	50%	CaO	3	7.29	0.5:1	(P14) $4.1\mathrm{x}10^{-6}$
				5	8.64		(P20) $1.5\mathrm{x}10^{-5}$
				10	9.14		(P15) $2.3\mathrm{x}10^{-6}$
XI	Commercial lime	50%	CaO	3	8.51	1:1	(P21) $2.9\mathrm{x}10^{-6}$
				5	19.80		(P23) $1.1\mathrm{x}10^{-6}$
				10	27.29		

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Table A-1
(continued)

	Sludge		Fixative		60-Day Compressive Strength Tons/ft^2	Fly Ash Ratio	Permeability cm/sec
	Type	Percent Solids	Type	(%) Amount			
IX	Commercial lime	50%	CaO	3	12.50	1.5:1	(P16) 5.7x10^{-7}
				5	35.85		
				10	58.25		
	Commercial lime	50%	Ca(OH)$_2$	3	1.02	0.5:1	
				5	8.86		
				10	6.94		(P24) 1.8x10^{-5}
XII	Commercial lime	50%	Ca(OH)$_2$	3	7.13	1:1	(P22) 9.2x10^{-6}
				5	21.71		
				10	33.98		
	Commercial lime	50%	Ca(OH)$_2$	3	13.66	1.5:1	(P25) 3.8x10^{-6}
				5	26.96		
				10	56.53		
	Commercial lime	65%	Portland Cement	3	3.44	0:1	
				5	3.94		
	Commercial lime	65%	Portland Cement	3	4.46	0.5:1	
				5	4.59		
VII	Commercial lime	65%	none	0	3.02	1:1	(P10) 7.0x10^{-6}
	Commercial lime	65%	Portland Cement	3	7.64	1:1	
				5	9.41		
	Commercial lime	65%	CaO	3	5.68	0.5:1	
				5	13.11		
				10	10.73		
	Commercial lime	65%	Ca(OH)$_2$	3	4.98	1:1	
				5	8.38		
				10	7.88		

Table A-2

Leachate Analyses

Sample[3]	Volume#	Cond. µmho/cm^2	pH	TDS ppm[1]	Cl- ppm	$SO_3^=$ ppm[2]	Cd ppm	Cu ppm	Pb ppm	Hg ppm	As ppm	$SO_4^=$ ppm	Ca ppm	Mg ppm	Se ppm	Sludge Composition	F/S	Fixative
(I) P1	1&2	3550	11.4	-	115	-	<.01	.02	.1	.003	-	1580	300	.05	.019	24% Carbide Lime Sludge	1:1	5% Carbide
	5&6	2350	11.1	-	<5	65[6]	<.01	.02	.1	.002	.03	1470	310	.05	.006			
P2	1&2	8180	12.3	-	180	60[1]	.02	.02	.1	.008	.04	1320	540	.01	.015	24% Carbide Lime Sludge	1:1	25% Carbide
	5&6	7370	12.2	-	<5	70[6]	.02	.02	.1	.003	.01	1530	590	.01	.004			
(II) P3	1&2	4090	8.4	2500	250	50[1]	.02	.06	.1	.002	.05	1860	250	.10	.034	42% Carbide Lime Sludge	1:1	5% Carbide
	5&6	2300	7.8	1400	<5	55	.01	<.02	<.1	.013	.01	2050	560	.26	.005			
P4	1&2	3150	9.3	1900	60	115	<.01	.08	<.1	.010	.01	1440	16	.01	.010	42% Carbide Lime Sludge	1:1	15% Carbide
	5&6	----	---	----	--	---	----	---	---	----	---	----	---	---	----			
(III) P5	1&2	3750	8.0	2200	155	20[1]	.02	.08	.1	.001	.07	1550	230	.06	.015	42% Carbide Lime Sludge	1:1	5% CaO
	5&6	2200	---	----	10	---	.02	.09	---	.003	.015	1030	650	.28	.003			
(V) P6	1&2	4350	7.9	2600	335	5[1]	.02	.06	.1	.001	.05	1940	360	.14	.028	55% Carbide Lime Sludge	1:1	0
	5&6	2050	---	----	10	---	.01	.02	---	.019	.019	980	.700	.20	.005			
(VI) P7	1&2	NA														55% Carbide Lime Sludge	1:1	3% Carbide
	5&6	NA																
P8	1&2	6850	7.8	4100	345	30[1]	.02	.06	.2	.001	.05	5390	260	940	.023	55% Carbide Lime Sludge	0:1	0
	5&6	2500	7.5	1500	<5	-	<.01	.02	.1	.002	.01	1960	300	130	.002			
(IV) P9	1&2	2600	---	----	200	---	.01	.08	<.1	.007	.03	1550	130	.03	.007	55% Carbide Lime Sludge	0:1	5% CaO
	5&6	NA																
(VII) P10	1&2	2850	7.8	1700	10	40[1]	.02	.02	.1	.018	.03	1580	320	.18	-	65% Commercial Lime	1:1	0
	5&6	2000	7.7	1200	15	-	<.01	.02	.1	.001	.03	1470	300	.15	.003			
P11	1&2	2450	8.9	1500	10	60[1]	.02	.04	.1	.003	-	1390	250	.17	.003	50% Commercial Lime	0.5:1	3% P.C.
	5&6	550	9.2	300	<5	60[6]	<.01	<.02	<.1	.001	.02	280	70	.06	<.001			

Table A-2(Continued)
LEACHATE ANALYSES

Sample	Volume #	Cond mho/cm	pH	TDS ~ppm	Cl^- ppm	$SO_3^=$ ppm	Cd ppm	Cu ppm	Pb ppm	Hg ppm	As ppm	$SO_4^{=*}$ ppm	Ca ppm	Mg ppm	Se ppm	Sludge Composition	F/S	Fixative
P3	5 & 6	2300	7.8	1400	<5	55	.01	<.02	<.1	.013	.01	2050	560	.26	.005	42% Carbide Lime Sludge	1:1	5% Carbide
P4	1 & 2	3150	9.3	1900	60	115	<.01	.08	<.1	.010	.01	1440	16	.01	.010	42% Carbide Lime Sludge	1:1	15% Carbide
P5	5 & 6	2200	-	-	10	-	.02	.09		.003	.015	1030	650	.28	.003	42% Carbide Lime Sludge	1:1	5% CaO
P6	5 & 6	2050	-	-	10	-	.01	.02		.019	.019	980	700	.20	.005	55% Carbide Lime Sludge	1:1	0
P9	1 & 2	2600	-	-	200	-	.01	.08	<.1	.007	.03	1550	130	.03	.007	55% Carbide Lime Sludge	0:1	5% CaO
P17	1 & 2	2150	9.9	1300	10	35	.01	<.02		.002	.006	910	490	.07	.007	50% Commercial Lime	0.5:1	5% P.C
	5 & 6	785	10.9	-	<5	15	.01	<.02		.003	.001	153	100	.04	.002	50% Commercial Lime	0.5:1	5% P.C
(X) P18	1 & 2	2550	9.2	1400	20	30	.01	<.02		.002	.007	1320	650	.10	.010	50% Commercial Lime	1:1	3% P.C
	5 & 6	575	8.0	345	<5	20	.01	<.02		.002	.003	218	110	.04	<.001	50% Commercial Lime	1:1	3% P.C
P19	1 & 2	1800	8.9	1100	15	<5	.01	<.02		.001	.005	470	170	.09	.010	50% Commercial Lime	1:1	5% P.C
P20	1 & 2	5700	-	-	95	-	.01	.05		.003	<.001	430	880	.02	.007	50% Commercial Lime	0.5:1	5% CaO
	5 - >10	6400	11.7	-	10	-	.01	<.02		.001	.001	85	770	.02	.003	50% Commercial Lime	0.5:1	5% CaO
(XII)P22	1 & 2	1350	11.1	-	10	20	.01	<.02		.001	.001	142	20	.01	.006	50% Commercial Lime	1:1	3% $Ca(OH)_2$
P23	1 & 2	3930	12.0	-	65	-	.01	.02		.002	<.001	5	350	.01	.005	50% Commercial Lime	1:1	5% CaO
P24	1 & 2	6400	-	-	90	-	.02	.02		.001	.002	540	990	.02	.007	50% Commercial Lime	0.5:1	10% $Ca(OH)_2$

$^*SO_4^=$ is total sulfur expressed as sulfate

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Table A-2(Continued)

Leachate Analyses

Sample[3]	Volume #	Cond µmho/cm^2	pH	TDS[1] ppm	Cl- ppm	SO3=[2] ppm	Cd ppm	Cu ppm	Pb ppm	Hg ppm	As ppm	SO4= ppm	Ca ppm	Mg ppm	Se ppm	Sludge Composition	F/S	Fixative
P12	1&2	2200	11.6	-	<5	85^1	<.01	.04	<.1	.002	<.01	270	11	.01	.004	50% Commercial Lime	0.5:1	10% P.C.
	5&6	420	9.7	250	<5	105	<.01	.02	<.1	<.001	<.01	110	14	.02	.003			
P13	1&2	2650	8.0	1600	20	35^1	<.01	.02	.1	.069	.02	1550	200	.21	.009	50% Commercial Lime	1.5:1	3% P.C.
	5&6	620	9.1	370	<5	210	<.01	<.02	<.1	.001	.03	260	95	.12	.002			
(VIII) P14	1&2	5650	12.2	-	10	-	.02	.02	.1	.001	.01	140	240	.01	.002	50% Commercial Lime	0.5:1	3% CaO
	5&6	3850	12.1	-	15	-	<.01	.02	.1	.002	<.01	44	160	.01	.002			
P15	1&2	6690^2	12.1^2	-	<5	45^2	.02	.06	.1	.001	<.01	840	470	.38	.004	50% Commercial Lime	0:5:1	10% CaO
	5&6	5400	12.2	-	<5	-	<.01	.02	.1	.001	<.01	110	270	.01	.003			
(IX) P16	1&2	1800	9.3	1100	15	230	<.01	<.02	<.1	.001	.01	440	6.7	.02	.008	50% Commercial Lime	1.5:1	3% CaO
	5&6	----	----	----	--	---	---	---	---	----	---	----	-----	---	----			

1. The total dissolved solids is in approximate value obtained from the conductivity; this approximation can only be made if the pH is between 5 and 10. Absolute values for TDS cannot be obtained for these samples.

2. Samples marked on the basis of permeability runs (See Table 1); superscripts denote pore volume used.

3. Roman numerals refer to mixtures selected for field demonstration (See Table 1). Samples III, IV and VI have not been sufficiently permeable to allow collection of leachate sample.

*SO_4 = is total sulfur expressed as SO_4=

Research KDL
EPA-LG&E Waste Disposal Laboratory Report
January, 1977

Unconfined compressive strength tests have been completed on all 59 fly ash/sludge mixtures. These results are included in Table A-1 along with the results of the first 24 permeability tests.

The unconfined compressive strength tests were carried out on samples cured for 60 days in a humidity chamber. The permeability determinations were made on samples confined for 30 days under water.

Table A-2 contains results of trace element analyses on leachate obtained from the 24 permeability tests. As a result of small sample size, the first and second, as well as the fifth and sixth pore volumes were combined prior to analysis.

The field test program calls for selection of carbide and commercial lime/fly ash mixtures for impoundment, and six mixtures were selected for each sludge type. These mixtures are designated in Table A-1.

Discussion

Unconfined compressive strengths ranged from 1 to 58 tons/ft^2 except for those mixtures made with 24% solids (simulated thickener underflow), which remained too soft to measure even after 60 days curing. Since a minimum shear strength of 0.25 tons or 0.5 tons/ft^2 unconfined compressive strength is considered acceptable for recreational or light structural landfill, final selection for field demonstration was based on the amount of fixative required and the experimental permeability.

The permeability criteria established in this project for acceptable landfill material was that permeability would be 10^{-6} to 10^{-7} cm/sec, a rate similar to that of medium stiff kaolinite clay. Permeabilities determined thus far ranged from about 3×10^{-6} to 6×10^{-7} except for the mixtures made with the 24% solids (thickener underflow) which were more permeable by a factor of ten.

Selection of mixtures made with carbide lime sludge are designated by Roman numerals in Table A-1. A total of six mixtures was selected. Some of the mixtures will be evaluated in both large and small impoundments for comparison. The commercial lime sludge mixtures were also selected for demonstration.

Leachate analyses are shown in Table A-2 for all of the 24 mixtures on which initial permeability determinations have been made. Two of the mixtures had such low permeabilities that sufficient leachate for analysis has yet to be collected. In general, trace element concentrations have been reduced considerably between the first and sixth pore volumes collected.

Preliminary review of the data indicates that the carbide sludge/fly ash samples appear to be more subject to the solubilizing of sulfate than do the commercial lime mixtures. Considerably more information will be required from the field tests before definitive conclusions on the selection of optimum mixtures can be made.

In accordance with the test plan, samples of the selected Phase I sludge/fly ash mixtures are undergoing four-cycle freeze/thaw tests after a 7-8 day curing period. Similar tests after longer curing periods are also anticipated. Phase II (commercial lime sludge) mixtures will also undergo freeze/thaw testing.

EPA-LG&E Waste Disposal Demonstration
Laboratory Phase
Project 900146

November 12, 1976

Freeze thaw tests were performed on the six carbide lime mixtures chosen for field demonstrations at LG&E. The mixtures were prepared and cured in a humid atmosphere for seven days. The cured samples were then subjected to cycles of freezing and thawing. The ASTM D560 Method for Freezing and Thawing Tests of Compacted Soil Cement Mixtures was used, with the number of freeze-thaw cycles reduced from twelve to four.

The following mixtures were tested:

Carbide Lime Sludge	Fixative	Fly Ash to Sludge Ratio	Sample Number	Field Mix Number
24% solids	5% Carbide	1:1	60	1
42% solids	5% Carbide	1:1	64	2
42% solids	3% CaO	1:1	67	3
55% solids	5% Carbide	0:1	55	4
55% solids	0	1:1	56	5
55% solids	3% Carbide	1:1	57	6

The results of the freeze thaw tests on the first set of samples are given in Table A-3 in terms of volume change during each cycle and initial and final moisture contents. Qualitative information can be gained from this study, but strict quantitative evaluations such as those included in the ASTM test method are not possible due to the severe cracking during freezing and soft consistency during thawing of the samples. The freeze thaw test is intended for soil-cement mixtures and it is doubtful whether there is a correlation between the results of these tests and the suitability of stabalized sludge materials for landfill disposal. Only the top few feet of a landfill would be subject to freezing and any structures constructed on the landfill could be designed to eliminate this effect by putting foundations below the frost line. Very few soils presently used as landfill material would meet the requirements of ASTM test D560.

Discussion of Results

As shown in Table A-3the 24% solids mixtures (Sample #60) did not solidify during the seven-day curing period and was not able to be removed from the mold. When the other samples were removed from the curing molds, the bottom portion of samples 55, 56, 57, and 64 broke off, leaving shorter samples than the 6-inch high samples originally molded. Because the samples were still somewhat soft, the duplicate set of samples were placed back in the humidity chambers to allow them to cure for sixty days before freeze-thaw testing.

The seven-day cure samples were frozen at -10°C for twenty-four hours, then allowed to thaw in a humidity chamber at 20°C for twenty-four hours. This cycle was repeated four times. The physical dimensions of each sample were recorded after each freeze and each thaw period. Table A-3 shows the volume change experienced by each sample during progress of the test. Generally, the samples expanded while freezing and contracted during thawing.

Sample No. 57 (55% solids, 3% carbide fixative, 1:1 fly ash to sludge ratio) fell apart during the first thaw period. Of the remaining samples, No. 55 cracked severely but still held together while Nos. 64 and 67 experienced less severe cracking. It is interesting to note that the samples which cracked the most (55 and 56) also showed the greatest increases in moisture content during the test.

Trends are shown in Figures A-1 through A-4.

Table A-3

SAMPLE	INIT VOL cc	MOISTURE CONTENT		AFTER 1ST FREEZE		AFTER 1ST THAW		AFTER 2ND FREEZE		AFTER 2ND THAW		AFTER 3RD FREEZE		AFTER 3RD THAW		AFTER 4TH FREEZE		AFTER 4TH THAW	
		INIT %	FINAL %	VOL cc	% OF ORIG VOL	VOL cc	% OF ORIG VOL	VOL cc	% OF ORIG VOL	VOL cc	% OF ORIG VOL	VOL cc	% OF ORIG VOL	VOL cc	% OF ORIG VOL	VOL cc	% OF ORIG VOL	VOL cc	% OF ORIG VOL
60 24% solids 5% carbide 1:1 F:S		TOO SOFT TO REMOVE FROM MOLD ----------																	
64 42% solids 5% carbide 1:1 F:S	442.0	40.2	41.1	452.9	102.4	440.0	99.5	453.5	102.6	431.7	97.7	454.2	102.7	468.9	106.1	462.7	104.7	466.3	105.5
67 42% solids 3% CaO 1:1 F:S	665.7	40.5	41.8	681.2	102.3	659.0	99.0	690.9	103.8	660.5	99.2	679.5	102.1	672.2	101.0	706.0	106.0	680.7	102.2
55 55% solids 5% carbide 0:1 F:S	289.3	43.8	49.0	288.3	99.6	NO HEIGHT MEASURED		323.1	111.7	274.7	94.9	NO HEIGHT MEASURED		NO HEIGHT MEASURED		334.5	115.6	296.3	102.4
56 55% solids 0 fixative 1:1 F:S	468.2	29.0	33.1	487.7	104.2	NO HEIGHT MEASURED		516.0	110.2	498.8	106.5	517.9	110.6	498.9	106.5	524.6	112.0	504.4	107.7
57 55% solids 3% carbide 1:1 F:S	392.6	28.5		398.9	101.6	FELL APART AFTER THAW ----------													

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BOTTOM OF IMAGE AREA OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
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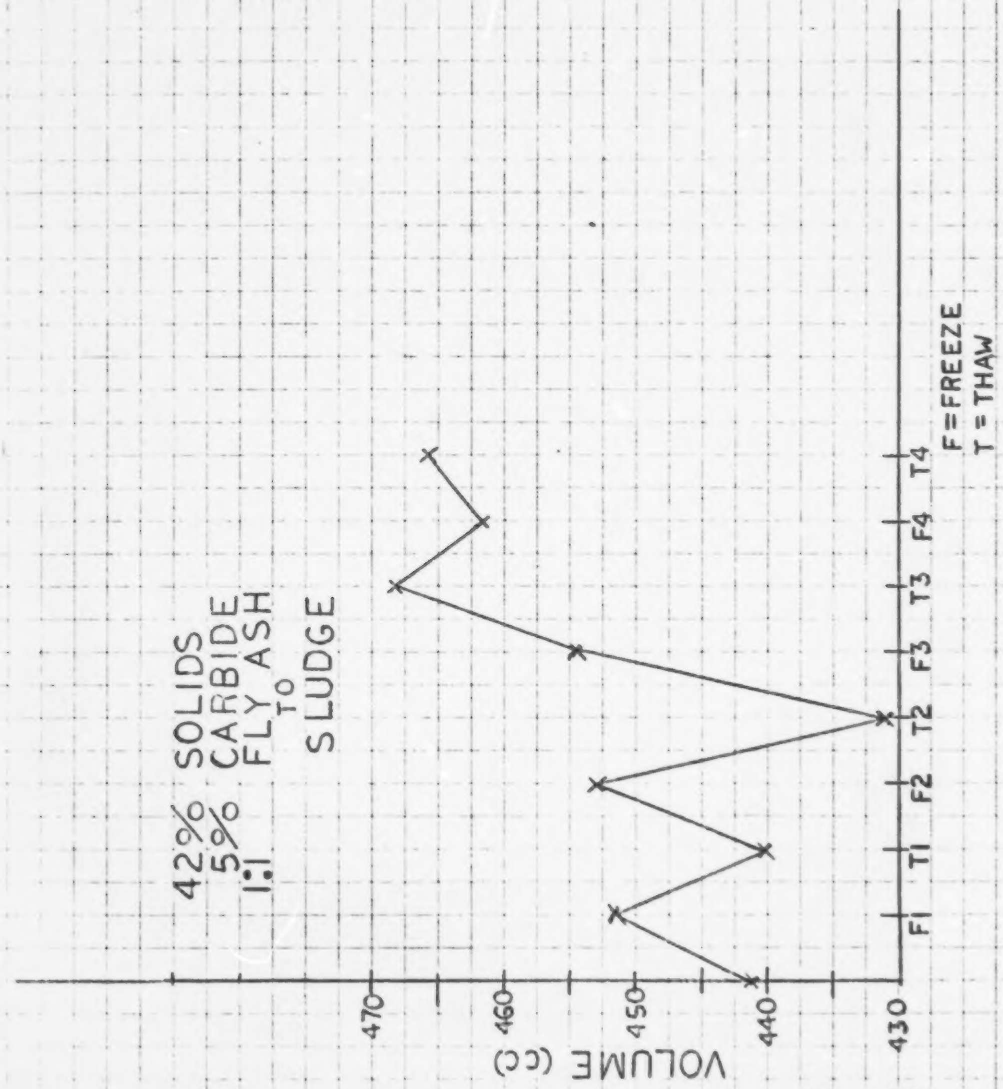

Figure A-1
Sample 64

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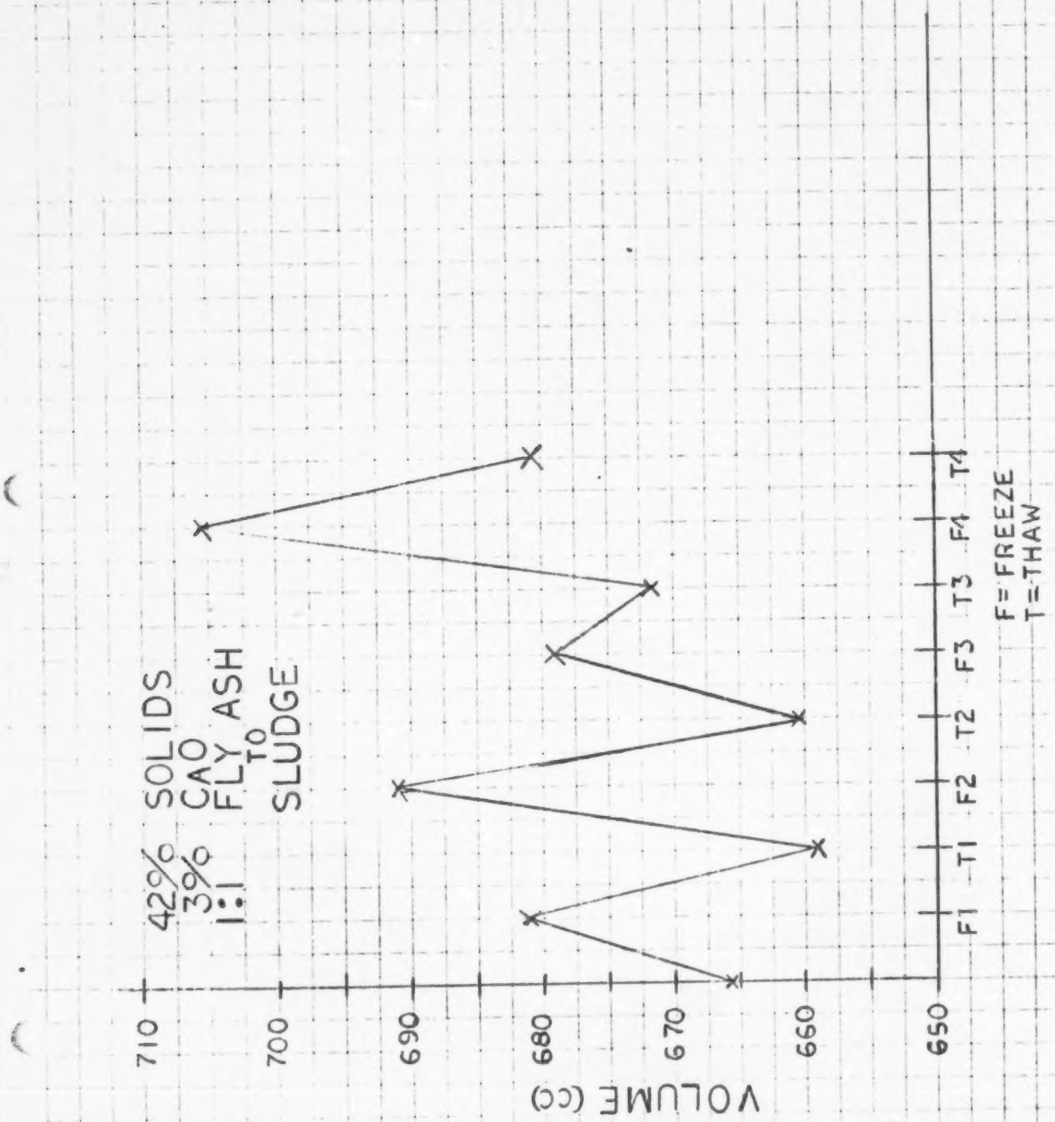

Figure A-2
Sample 67

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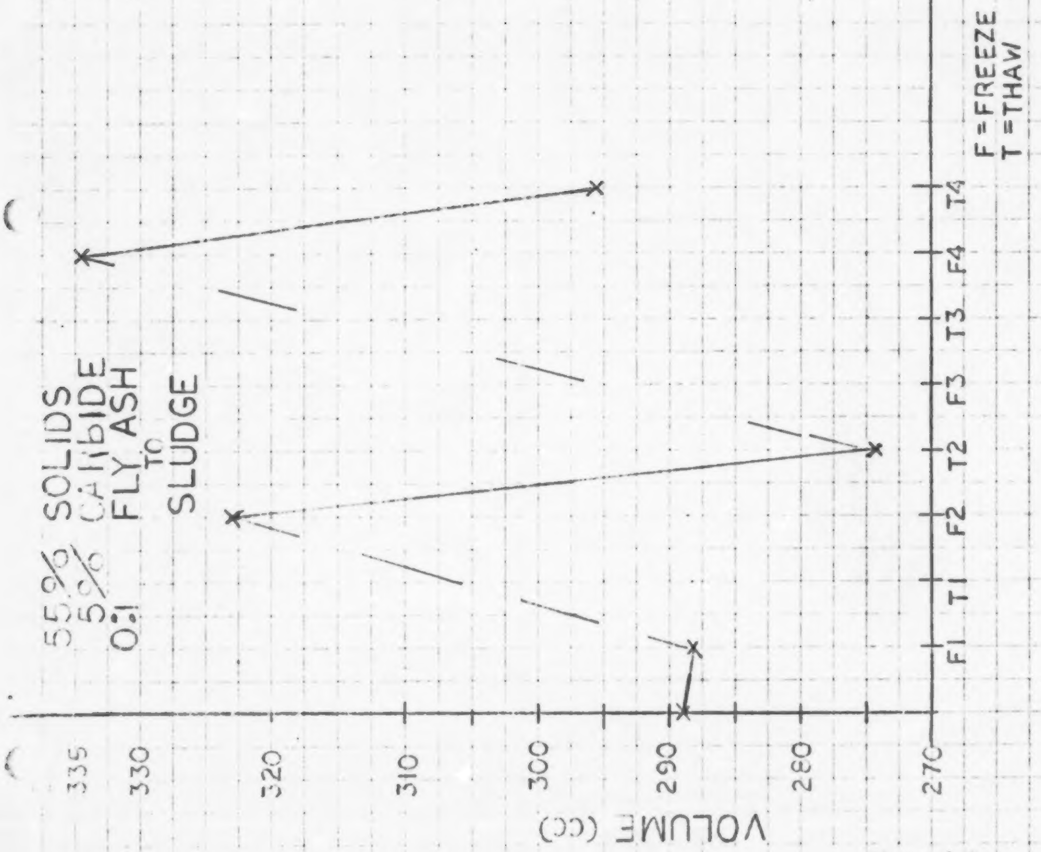

Figure A-3
Sample 55

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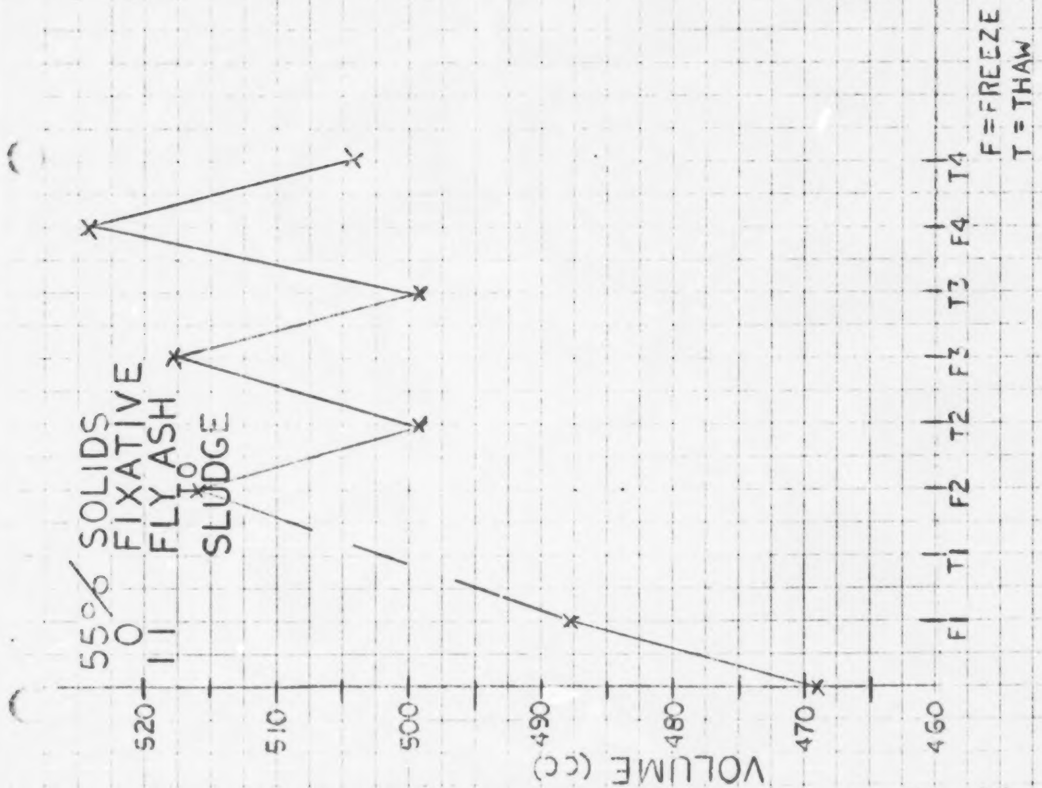

Figure A-4
Sample 56

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3/8"

APPENDIX B

ANALYTICAL DATA - LEACHATE ANALYSES

Attached is the final data summary for the leachate analyses conducted as part of the LG&E C-E Waste Disposal Study.

Data from all required analyses, except for the determination of cyanide, are included. Although extensive time and effort were put into evaluating and modifying various methods for this determination, all methods proved to be unsatisfactory for the determination of the low levels of cyanide in typical leachate solutions. Therefore, this analysis was not performed.

The summary consists (for the most part) of data from thirty-three specific determinations on one-hundred twenty one samples. With the additional work required to duplicate and confirm anomalous data, well over four thousand separate analyses were performed.

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BOTTOM OF IMAGE AREA; OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS

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Sulfite	155	156	
Total Dissolved Solids	157	159	
Vanadium	162	163	
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BOTTOM OF IMAGE AREA: OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS

INTRODUCTION

The following is provided in order to explain certain terms and expressions which are frequently encountered in this data summary. Where thought to be of some aid in correctly assessing this data, pertinent background information is also included, for your information.

The terms which follow immediately apply to the samples in general and to the analytical results in general.

Site designations for required samples:

S: Small, above-ground impoundments.
These are also referred to as pools.

L: Large, in-ground impoundments.
These are also referred to as pits.

Zone designations for S sites:

1 (BOR): Bottom outer ring.
2 (OF): Overflow.
3 (BIR): Bottom inner ring.

Zone designations for L sites:

6": Six inches below bottom of impoundment.
2': Two feet below bottom of impoundment.
6': Six feet below bottom of impoundment.

Reference samples:

These samples were taken at the LG&E Cane Run Station, and they consist of rainwater, water from an inactive test well designated "government well," and water from an active well designated "#5 deep well." These samples are not required as part of this project, but they were obtained and analyzed in order to provide background data against which the analytical data for the leachates might be compared.

The two sets of rainwater samples, obtained in August, 1977, and December, 1978, were both collected in the immediate vicinity of the impoundment sites, but the compositions of these samples differ significantly. The first sample contained a relatively large amount (equivalent to about 100 mg/l) of a very fine, grayish material, similar in appearance to flyash; the second sample was essentially free of suspended material. Considering only the concentrations solubilized by the rainwater, for those analytes for which meaningful data is available the concentrations in the first sample are greater than the concentrations in the second sample by factors that range from about two to about six. For those analytes which are generally water-insoluble (and therefore present in the suspended material in the first sample) and in those cases where the analytical method determines the total concentration, the concentrations in the first sample are greater than the concentrations in the second sample by factors as high as fifty.

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The inactive government test well is located about eight hundred yards from the large, in-ground impoundments; the active #5 deep well is located about four hundred yards from the same area. For both wells two sets of samples were obtained, one in February, 1977, and one in October, 1977. In the case of the government test well, the concentration of a given analyte was about the same in the first sample as it was in the second sample. In the case of the #5 deep well, however, the concentrations were generally higher for the second sample than they were for the first sample. As reflected in the total dissolved solids, the concentration of the second sample is about six times higher than the concentration of the first sample. Furthermore, the concentration of TDS in the second sample from the #5 deep well is comparable to the concentration of TDS in the first and second samples from the government test well.

The reasons for the marked differences in the concentrations of those constituents analyzed in the two samples from the #5 deep well are not known, but two possible explanations are given below.

1. In the case of the first (February, 1977) sample, the well water may have been diluted by runoff from melting snow. Analytical data for the leachates confirms the suspicion of LG&E personnel that at least one leachate sample (S1-3 (BIR), 90 day, sampled on 2-9-77) was contaminated in this fashion.

2. In the case of the second (October, 1977) sample, the well water may have been contaminated by leachate from sludge or flyash disposal sites. If this in fact was the case, it seems unlikely that the source of contamination was the sludge-flyash impoundments for this project, since the TDS concentrations in the samples from the #5 deep well (which is much closer to the impoundment sites than the government test well) are definately lower than the TDS concentrations in the samples from the government test well.

mg/l: Milligrams of analyte per liter of leachate.
Milligrams per liter is equivalent to parts per million (ppm) on a weight per volume basis.

µmho/cm: Micro mhos per centimeter.
A micro mho is equivalent to 10^{-6} reciprocal ohms.

The terms below apply to specific samples.

HS: Heterogeneous sample

At the time of analysis these samples contained suspended material. The material varied from pale yellow to brown in coloration, and its appearance was that of a colloid. In some cases a fibrous, non-crystalline material developed from the colloidal matter. In conversations with LG&E personnel it was found that these samples were in fact filtered as specified below and that they were clear (but colored) when shipped to C-E. For the most part the suspended material had developed while the samples were in transit to C-E; in a few cases the suspended material developed after the samples were received at C-E. Furthermore, from all appearances the leachates as obtained at the impoundment sites contained the same suspended material, and this material had been extremely difficult to remove by filtration.

X-ray fluorescence analysis of the suspended material in one sample (S1-1 (BOR), 180 day) determined the presence of sulfur, calcium, iron, silicon, and potassium in the order of S > Ca > Fe, Si, K. However, based on previous experience the total

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quantity of these materials appeared to be much less than the quantity of material analyzed. And it was not likely that any metallic element not determined by XRF (but especially sodium or magnesium) contributed significantly to the difference. (Elements whose atomic number is less than thirteen are not determined by XRF). X-ray diffraction analysis of the same sample determined only silicon dioxide as a crystalline component of the suspended material. Noteworthy in their absence were any form of hydrated iron oxide or calcium sulfate, although the hydrated iron oxide could have been present at a low concentration as an amorphous, non-crystalline material. It is not even likely that the silica was the source of the problem since the silica would have had to be present as colloidal silica, which is determinable by flame atomic absorption, and which was determined to be less than one milligram per liter. Concentrations of colloidal silica in the order of ten thousand milligrams per liter would have been required to produce the hazy appearance of this sample. The sulfur, calcium and potassium detected (and possibly sodium) were probably due to incomplete washing of the filter.

Our suspicion is that the suspended material is composed primarily of bacterial organisms, namely, sulfate reducing bacteria, sulfur bacteria, and iron bacteria. Although the presence of bacterial organisms such as these has not been established beyond doubt, the following observations and considerations lead us to believe that these bacteria are present in at least some of the leachates and that in some of those cases they are present in relatively high concentrations. First of all, literature indicates that it is entirely possible for these sorts of bacteria to live in, and to even flourish in, aqueous solutions such as the leachates. Secondly, in those cases where the leachates developed the hazy, colloidal appearance discussed above, there was a strong odor of hydrogen sulfide. Hydrogen sulfide is the end-product of the metabolism of sulfate by sulfate-reducing bacteria; the ASTM (D993) method for quantifying this bacteria consists of determining the H_2S produced by the bacteria under specified conditions in a specified culture medium. Thirdly, microscopic examination of the leachates has revealed, in the hazy, colloidal leachates and in other leachates, the presence of what appears to be two varieties of iron bacteria: the Gallionella stalked bacteria, and filamentous bacteria similar to Sphaerotilus, Leptothrix, or Clonothrix. And fourtnly, in one case a leachate sample which had been in storage for about a year developed what appeared to be a bacterial growth which completely covered the exposed surface of the leachate.

IS: Insufficient sample.

In these cases an inordinately small quantity of leachate was obtained at LG&E and forwarded to C-E. In some of these cases, in order to satisfactorily determine those constituents considered to be most important it was necessary to completely eliminate other analyses. In other cases, while a given analysis was in fact performed, the limitation of sample size preclude the determination of the analyte to the normal level of precision and to the normal level of detectability.

ISP: Inoperable sample point.

NRS: Non-representative sample.

On a few occasions leachate samples which are thought to be extremely unrepresentative of the actual leachate were sent to C-E for analysis. In two cases (S1-1 (BOR), 90 day, and S1-2 (OF), 90 day) the concentration of total dissolved solids in the sample was much higher than usual, leading us to suspect that the leachate had partially frozen before or during sampling. Freezing a hypoeutectic (less than eutectic) solution causes the solvent to precipitate first, thus concentrating the remaining solution. In the other case (S1-3 (BIR), 90 day) the leachate was diluted by rain or snow. These sources of poor sampling are designated as follows:

NRS (F): Non-representative sample due to freezing.
NRS (R): Non-representative sample due to rain or snow.

NS: No sample.

It is assumed that in these cases an attempt was made by LG&E personnel to obtain the specified leachate sample, but either no leachate was available (as in the case of the S impoundments) or no leachate was obtained using the recommended sampling procedure (as in the case of the L impoundments). However, in order to differentiate between the above and those cases where correspondence verifies that there was an attempt to sample, the latter is designated as follows:

NS(A): No sample; sampling attempted.

It should be noted that prior to 1978 the period of time over which the pressure-vacuum samplers for the L impoundments were activated was extended sometimes up to three weeks in order to obtain (or attempt to obtain) the volume of leachate required for complete analysis. During 1978 the period of time over which the samplers were activated was limited to twenty-four hours for the two-foot and six-foot zones, but it remained unrestricted for the six-inch zone.

US: Unfiltered sample.

This applies strictly to the rainwater samples which were obtained near the impoundment sites at Cane Run. Analytical data for these samples are not required but are provided for the purpose of comparison. Since the first sample, which was obtained in August, 1977, was extremely dirty, containing a large amount of dark, particulate matter (apparently flyash), it was thought that the determination of the total concentration of the various constituents, whether dissolved or particulate, could provide useful information. To that end, where possible within the limitations of the analytical method, the total concentration of the specified analyte is given. Often though, a method determines the concentration of an analyte as dissolved material entirely but as particulate material only slightly. For this reason the designation "US" is further specified as follows:

US (D): Dissolved analyte in unfiltered sample.
The method essentially determines only the concentration of the analyte dissolved and in solution at the time of analysis.

US (T): Total analyte in unfiltered sample.
The method essentially determines the total concentration of the analyte from dissolved matter and particulate matter.

The second rainwater sample was obtained in December, 1978. This sample, in stark contrast to the first sample, was clear, colorless, and essentially free of particulate matter. This sample was also analyzed on an unfiltered basis, but in this case the difference between the concentration of a given analyte as dissolved matter or as total matter is insignificant.

All samples except those designated US were filtered thru cellulosic filter media of 0.45 millimeter pore size at LG&E before shipment to C-E. The intent of this filtration was to obtain leachate solutions which conform to the ASTM (D 1888) definition for dissolved matter.

V: Variant analytical data.

For this project, if such quantities were available, two liters of unacidified leachate and one liter of acidified leachate were obtained and forwarded to C-E KDL from LG&E. In a few cases significant variations in the concentrations of the major leachate components in these samples were found. In two of these cases no concrete explanation could be given for the sample variation and no justification could be found for the exclusion of any of the data.

For the 0 day leachate sample from L2-6', the concentrations of the various constituents in the first sample (obtained 12/9-14/76) are much greater than the concentrations of the corresponding constituents in the second sample (obtained 2/15-20/76). In this case it is assumed that the differences in concentrations are due to the fact that the first sample is primarily leachate and that the second sample is primarily ground water. Data reported are therefore for the first (12/9-14/76) sample. Where possible, data for the second (12/15-20/76) sample are inserted parenthetically.

For the 630 day leachate sample from L1-6", the concentrations of the various constituents in the first sample (obtained 7/12-17/78) are significantly less than the concentrations of the corresponding constituents in the second and third samples (obtained 7/18-21/78 and 7/21-26/78). In this case an acceptable rationale for the variations of concentrations noted in the samples is not readily apparent. The required analytical values are therefore reported as average values, designated as follows:

V (M): Mean value of variant analytical data.

Where significant, the actual analytical values for the three samples for the 630 day leachate from L1-6" are reported parenthetically.

SAMPLING SCHEDULE

(S IMPOUNDMENTS)

Site	Zone	0 Day Scheduled	0 Day Sampled	30 Day Scheduled	30 Day Sampled	60 Day Scheduled	60 Day Sampled	90 Day Scheduled	90 Day Sampled	120 Day Scheduled	120 Day Sampled
S1	1 (BOR)	11/11/76	11/22/76	12/11/76	12/11/76	1/10/77	NS(A)	2/9/77	2/9/77(NRS(F))		
	2 (OF)	11/11/76	11/19/76	12/11/76	12/11/76	1/10/77	NS(A)	2/9/77	2/9/77(NRS(F))		
	3 (BIR)	11/11/76	11/19/76	12/11/76	NS	1/10/77	NS(A)	2/9/77	2/9/77(NRS(R))		
S2	1 (BOR)	11/23/76	NS	12/23/76	NS(A)	1/22/77	NS(A)	2/21/77	NS(A)		
	2 (OF)	11/23/76	NS	12/23/76	NS(A)	1/22/77	NS(A)	2/21/77	2/21/77		
	3 (BIR)	11/23/76	NS	12/23/76	NS(A)	1/22/77	NS(A)	2/21/77	NS(A)		
S3	1 (BOR)	12/8/76	NS	1/7/77	NS(A)	2/6/77	NS(A)	3/8/77	NS		
	2 (OF)	12/8/76	NS	1/7/77	NS(A)	2/6/77	NS(A)	3/8/77	3/1/77		
	3 (BIR)	12/8/76	NS	1/7/77	NS(A)	2/6/77	NS(A)	3/8/77	NS		
S4	1 (BOR)	12/11/76	NS	1/10/77	NS(A)	2/9/77	NS(A)	3/11/77	NS		
	2 (OF)	12/11/76	NS	1/10/77	NS(A)	2/9/77	NS(A)	3/11/77	3/1/77		
	3 (BIR)	12/11/76	NS	1/10/77	NS(A)	2/9/77	NS(A)	3/11/77	3/1/77		
S5	1 (BOR)	7/13/77	NS(A)	8/12/77	NS(A)	9/11/77	9/13/77	10/11/77	10/12/77		
	2 (OF)	7/13/77	NS(A)	8/12/77	NS(A)	9/11/77	9/13/77	10/11/77	NS(A)		
	3 (BIR)	7/13/77	7/13/77	8/12/77	NS(A)	9/11/77	9/13/77	10/11/77	10/12/77		
S6	1 (BOR)	7/13/77	NS(A)	8/12/77	NS(A)	9/11/77	9/13/77	10/11/77	10/12/77		
	2 (OF)	7/13/77	NS(A)	8/12/77	NS(A)	9/11/77	9/13/77	10/11/77	NS(A)		
	3 (BIR)	7/13/77	NS(A)	8/12/77	NS(A)	9/11/77	9/13/77	10/11/77	10/12/77		
S7	1 (BOR)	7/21/77	--	8/21/77	--	9/21/77	NS(A)	10/21/77	NS(A)	11/21/77	NS(A)
	2 (OF)	7/21/77	--	8/21/77	--	9/21/77	NS(A)	10/21/77	NS(A)	11/21/77	NS(A)
	3 (BIR)	7/21/77	--	8/21/77	--	9/21/77	NS(A)	10/21/77	NS(A)	11/21/77	NS(A)
S8	1 (BOR)	7/25/77	--	8/25/77	--	9/25/77	NS(A)	10/25/77	NS(A)	11/25/77	NS(A)
	2 (OF)	7/25/77	--	8/25/77	--	9/25/77	NS(A)	10/25/77	10/17/77	11/25/77	11/14/77
	3 (BIR)	7/25/77	--	8/25/77	--	9/25/77	NS(A)	10/25/77	10/17/77	11/25/77	11/14/77
S9	1 (BOR)	8/1/77	--	9/1/77	--	10/1/77	NS(A)	11/1/77	NS(A)	12/1/77	NS(A)
	2 (OF)	8/1/77	--	9/1/77	--	10/1/77	NS(A)	11/1/77	NS(A)	12/1/77	NS(A)
	3 (BIR)	8/1/77	--	9/1/77	--	10/1/77	NS(A)	11/1/77	10/17/77	12/1/77	NS(A)

SAMPLING SCHEDULE

(S IMPOUNDMENTS)

Site	Zone	180 Day Scheduled	180 Day Sampled	270 Day Scheduled	270 Day Sampled	360 Day Scheduled	360 Day Sampled	390 Day Scheduled	390 Day Sampled	450 Day Scheduled	450 Day Sampled
S1	1 (BOR)	5/10/77	5/10/77(HS)	8/8/77	9/20/77	11/6/77	11/7/77				
	2 (OF)	5/10/77	5/10/77(HS)	8/8/77	9/20/77	11/6/77	NS(A)				
	3 (BIR)	5/10/77	5/10/77(HS)	8/8/77	9/20/77	11/6/77	11/7/77				
S2	1 (BOR)	5/22/77	5/20/77	8/20/77	9/20/77	11/18/77	NS(A)				
	2 (OF)	5/22/77	5/20/77(HS)	8/20/77	9/20/77	11/18/77	11/18/77				
	3 (BIR)	5/22/77	5/20/77	8/20/77	9/20/77	11/18/77	11/18/77				
S3	1 (BOR)	6/6/77	6/6/77	9/4/77	9/20/77	12/3/77					
	2 (OF)	6/6/77	6/6/77(HS)	9/4/77	9/20/77	12/3/77					
	3 (BIR)	6/6/77	6/6/77	9/4/77	9/20/77	12/3/77					
S4	1 (BOR)	6/9/77	6/9/77	9/7/77	9/20/77	12/6/77					
	2 (OF)	6/9/77	6/9/77(HS)	9/7/77	9/20/77	12/6/77					
	3 (BIR)	6/9/77	6/9/77	9/7/77	9/20/77	12/6/77					
S5	1 (BOR)							7/17/78	NS	10/8/78	10/9/78
	2 (OF)							7/17/78	NS	10/8/78	NS(A)
	3 (BIR)							7/17/78	NS	10/8/78	NS(A)
S6	1 (BOR)							7/17/78	NS	10/8/78	10/9/78
	2 (OF)							7/17/78	8/17/78	10/8/78	NS(A)
	3 (BIR)							7/17/78	NS	10/8/78	NS(A)
S7	1 (BOR)							8/21/78	8/18/78		
	2 (OF)							8/21/78	8/18/78		
	3 (BIR)							8/21/78	NS		
S8	1 (BOR)							8/25/78	NS		
	2 (OF)							8/25/78	6/18/78		
	3 (BIR)							8/25/78	NS		
S9	1 (BOR)							9/1/78	NS		
	2 (OF)							9/1/78	8/18/78		
	3 (BIR)							9/1/78	NS		

SAMPLING SCHEDULE

(S IMPOUNDMENTS)

Site	Zone	480 Day		630 Day		660 Day	
		Scheduled	Sampled	Scheduled	Sampled	Scheduled	Sampled
S1	1 (BOR)			8/17/78	NS		
	2 (OF)			8/17/78	8/17/78		
	3 (BIR)			8/17/78	NS		
S2	1 (BOR)			8/17/78	8/17/78	10/3/78	NS(A)
	2 (OF)			8/17/78	8/17/78	10/3/78	10/9/78
	3 (BIR)			8/17/78	NS	10/3/78	NS(A)
S3	1 (BOR)			8/17/78	NS	10/3/78	NS(A)
	2 (OF)			8/17/78	NS	10/3/78	NS(A)
	3 (BIR)			8/17/78	NS	10/3/78	NS(A)
S4	1 (BOR)			8/17/78	NS	10/8/78	10/9/78
	2 (OF)			8/17/78	8/17/78	10/8/78	10/9/78
	3 (BIR)			8/17/78	NS	10/8/78	NS(A)
S5	1 (BOR)						
	2 (OF)						
	3 (BIR)						
S6	1 (BOR)						
	2 (OF)						
	3 (BIR)						
S7	1 (BOR)	11/21/78	NS(A)				
	2 (OF)	11/21/78	NS(A)				
	3 (BIR)	11/21/78	NS(A)				
S8	1 (BOR)	11/25/78	11/27/78 (NRS(R))				
	2 (OF)	11/25/78	11/27/78				
	3 (BIR)	11/25/78	NS(A)				
S9	1 (BOR)	12/1/78	NS(A)				
	2 (OF)	12/1/78	11/27/78				
	3 (BIR)	12/1/78	11/27/78				

BEGIN LAST LINE OF TEXT
3/8"
BOTTOM OF IMAGE AREA; OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
PAGE NUMBER
EPA Form 2350-4 (4-80)
(PREVIOUSLY C/N EPA FORM 367)
TYPING GUIDE SHEET

SAMPLING SCHEDULE

(L IMPOUNDMENTS)

		0 Day		30 Day		60 Day		90 Day	
Site	Zone	Scheduled	Sampled	Scheduled	Sampled	Scheduled	Sampled	Scheduled	Sampled
L1	6"	11/11/76	NS	12/11/76	12/9-13/76	1/10/77	1/7/77	2/9/77	2/10-17/77
	2'	11/11/76	NS	12/11/76	12/10-16/76	1/10/77	1/7/77	2/9/77	2/9/77
	6'	11/11/76	NS	12/11/76	12/9-15/76	1/10/77	1/7-13/77	2/9/77	ISP
L2	6"	12/6/76	12/9-13/76	1/5/77	1/11-13/77	2/4/77	2/4-21/77	3/6/77	NS
	2'	12/6/76	12/10-15/76(HS)	1/5/77	NS(A)	2/4/77	ISP	3/6/77	NS
	6'	12/6/76	12/9-20/76 (V)	1/5/77	1/3-11/77	2/4/77	2/4/77	3/6/77	NS
L3	6"	7/15/77	NS(A)	8/14/77	NS(A)	9/13/77	9/14-10/3/77	10/13/77	10/13-25/77
	2'	7/15/77	NS(A)	8/14/77	NS(A)	9/13/77	9/14/77	10/13/77	NS(A)
	6'	7/15/77	NS(A)	8/14/77	NS(A)	9/13/77	9/14/77	10/13/77	10/13/77
L4	6"	8/18/77	NS	9/17/77	9/16-20/77	10/17/77	NS(A)	11/16/77	NS(A)
	2'	8/18/77	NS	9/17/77	NS(A)	10/17/77	NS(A)	11/16/77	NS(A)
	6'	8/18/77	NS	9/17/77	NS(A)	10/17/77	NS(A)	11/16/77	NS(A)
L5	6"	8/18/77	NS	9/17/77	NS(A)	10/17/77	NS(A)	11/16/77	NS(A)
	2'	8/18/77	NS	9/17/77	NS(A)	10/17/77	NS(A)	11/16/77	NS(A)
	6'	8/18/77	NS	9/17/77	NS(A)	10/17/77	NS(A)	11/16/77	NS(A)

SAMPLING SCHEDULE

(L IMPOUNDMENTS)

		180 Day		270 Day		300 Day		360 Day		390 Day	
Site	Zone	Scheduled	Sampled	Scheduled	Sampled	Scheduled	Sampled	Scheduled	Sampled	Scheduled	Sampled
L1	6"	5/10/77	5/10-20/77	8/8/77	9/20-10/3/77			11/6/77	11/8-17/77		
	2'	5/10/77	NS	8/8/77	NS(A)			11/6/77	11/8-17/77		
	6'	5/10/77	ISP	8/8/77	NS(A)			11/6/77	NS(A)		
L2	6"	6/4/77	6/7-28/77	9/2/77	9/26-10/3/77						
	2'	6/4/77	6/7/77	9/2/77	NS(A)						
	6'	6/4/77	6/7/77	9/2/77	NS(A)						
L3	6"							7/10/78	7/14/-8/1/78		
	2'							7/10/78	7/12/78		
	6'							7/10/78	7/12/78		
L4	6"					6/14/78	6/20-26/78			9/15/78	NS
	2'					6/14/78	NS			9/15/78	NS
	6'					6/14/78	NS			9/15/78	NS
L5	6"					6/14/78	6/20-26/78			9/15/78	NS
	2'					6/14/78	NS			9/15/78	NS
	6'					6/14/78	NS			9/15/78	NS

BEGIN FIRST LINE OF TEXT HERE
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD; BEGIN SECTIONS HERE
BEGIN LAST LINE OF TEXT
3/8"
PAGE NUMBER
BOTTOM OF IMAGE AREA; OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
EPA Form 2350-4 (4-80)
(PREVIOUSLY CIN. EPA FORM 287)
TYPING GUIDE SHEET

SAMPLING SCHEDULE

(L IMPOUNDMENTS)

		450 Day		480 Day		570 Day		600 Day	
Site	Zone	Scheduled	Sampled	Scheduled	Sampled	Scheduled	Sampled	Scheduled	Sampled
L1	6"							7/6/78	7/12-26/78 (V)
	2'							7/6/78	7/12/78
	6'							7/6/78	NS
L2	6"					7/1/78	7/5-8/7/78		
	2'					7/1/78	NS		
	6'					7/1/78	7/12/78		
L3	6"	10/10/78	NS						
	2'	10/10/78	NS						
	6'	10/10/78	10/10/78						
L4	6"			12/8/78	11/29-12/5/78				
	2'			12/8/78	NS				
	6'			12/8/78	NS				
L5	6"			12/8/78	11/29-12/5/78				
	2'			12/8/78	NS				
	6'			12/8/78	NS				

SAMPLING SCHEDULE

(REFERENCE SAMPLES)

Sample	First Sampling	Second Sampling
Rainwater	8/22-24/77 (US)	12/4/78 (US)
Water from government test well	2/14/77	10/4/77
Water from #5 deep well	2/14/77	10/3/77

ALUMINUM (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day
S1	1 (BOR)	<1	<1	NS(A)	NRS(F)		0.1(HS)	0.1	0.1
	2 (OF)	<1	<1	NS(A)	NRS(F)		<0.1(HS)	<0.1	NS(A)
	3 (BIR)	<1	NS	NS(A)	NRS(R)		<0.1(HS)	0.1	0.2
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		0.2	0.2	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	<1		0.1(HS)	<0.1	<0.1
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		0.1	0.2	<0.1
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		<0.1	<0.1	
	2 (OF)	NS	NS(A)	NS(A)	<1		<0.1(HS)	<0.1	
	3 (BIR)	NS	NS(A)	NS(A)	NS		<0.1	<0.1	
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		<0.1	<0.1	
	2 (OF)	NS	NS(A)	NS(A)	<1		0.1(HS)	<0.1	
	3 (BIR)	NS	NS(A)	NS(A)	<1		0.1	0.2	
S5	1 (BOR)	NS(A)	NS(A)	<0.1	0.2				
	2 (OF)	NS(A)	NS(A)	<0.1	NS(A)				
	3 (BIR)	<0.1	NS(A)	<0.1	<0.1				
S6	1 (BOR)	NS(A)	NS(A)	0.2	<0.1				
	2 (OF)	NS(A)	NS(A)	<0.1	NS(A)				
	3 (BIR)	NS(A)	NS(A)	<0.1	<0.1				
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)			
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)			
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	0.1	0.2			
	3 (BIR)	--	--	NS(A)	0.2	0.2			
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)			
	3 (BIR)	--	--	NS(A)	0.2	NS(A)			

ALUMINUM (mg/l)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	360 Day
L1	6"	NS	<1	<1	<1	<0.1	0.2	0.2
	2'	NS	<1	IS	1	NS	NS(A)	<0.1
	6'	NS	<1	1	ISP	ISP	NS(A)	NS(A)
L2	6"	<1	<1	<1	NS	0.4	<0.1	
	2'	<1(HS)	NS(A)	ISP	NS	0.4	NS(A)	
	6'	<1(V)	<1	<1	NS	<0.1	NS(A)	
L3	6"	NS(A)	NS(A)	1.4	2.8			
	2'	NS(A)	NS(A)	3.2	NS(A)			
	6'	NS(A)	NS(A)	<0.1	<0.1			
L4	6"	NS	4.1	NS(A)	NS(A)			
	2'	NS	NS(A)	NS(A)	NS(A)			
	6'	NS	NS(A)	NS(A)	NS(A)			
L5	6"	NS	NS(A)	NS(A)	NS(A)			
	2'	NS	NS(A)	NS(A)	NS(A)			
	6'	NS	NS(A)	NS(A)	NS(A)			

ALUMINUM (mg/l)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77
Rainwater		0.2 (US(D))	
Water from government test well	<1		<0.1
Water from #5 deep well	<1		0.1

ARSENIC (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	0.014	0.011	NS(A)	NRS(F)		0.018(HS)	0.026	0.048				NS	
	2 (OF)	0.042	0.013	NS(A)	NRS(F)		0.013(HS)	0.019	NS(A)				0.040	
	3 (BIR)	0.020	NS	NS(A)	NRS(R)		0.017(HS)	0.028	0.042				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		0.004	0.012	NS(A)				0.004	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.003		0.005(HS)	0.012	0.004				0.004	0.001
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		0.006	0.012	0.012				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		0.002	0.002					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.005		0.014(HS)	0.012					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		0.007	0.005					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		0.002	0.008					NS	0.028
	2 (OF)	NS	NS(A)	NS(A)	0.010		0.005(HS)	0.010					0.024	0.008
	3 (BIR)	NS	NS(A)	NS(A)	0.001		0.004	0.003					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	0.014	0.010					NS	0.024			
	2 (OF)	NS(A)	NS(A)	0.018	NS(A)					NS	NS(A)			
	3 (BIR)	0.020	NS(A)	0.010	0.015					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	0.018	0.006					NS	0.011			
	2 (OF)	NS(A)	NS(A)	0.016	NS(A)					0.001	NS(A)			
	3 (BIR)	NS(A)	NS(A)	0.010	0.004					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				0.003		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.008		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	0.004	0.006				0.014		0.010		
	3 (BIR)	--	--	NS(A)	0.010	0.006				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.010		0.003		
	3 (BIR)	--	--	NS(A)	0.029	NS(A)				NS		0.006		

ARSENIC (mg/1)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	0.012	0.015	0.030	0.011	0.023		0.007					0.004 (V(M))
	2'	NS	0.003	0.004	IS	NS	NS(A)		0.006					0.002
	6'	NS	0.005	0.007	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	0.003	0.005	0.009	NS	0.006	0.018						0.001	
	2'	0.002(HS)	NS(A)	ISP	NS	0.004	NS(A)						NS	
	6'	<0.001(V)	<0.001	IS	NS	<0.001	NS(A)						<0.001	
L3	6"	NS(A)	NS(A)	0.004	0.002				<0.001		NS			
	2'	NS(A)	NS(A)	0.001	NS(A)				0.004		NS			
	6'	NS(A)	NS(A)	0.002	0.003				<0.001		<0.001			
L4	6"	NS	0.004	NS(A)	NS(A)			0.003		NS		0.006		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			<0.001		NS		0.002		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

ARSENIC (mg/1)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		0.049 (US(T))		0.008 (US)
Water from government test well	<0.001		0.002	
Water from #5 deep well	<0.001		0.002	

BARIUM (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	1.0	3.3	NS(A)	NRS(F)		<0.1(HS)	0.3	0.1				NS	
	2 (OF)	0.3	<0.2	NS(A)	NRS(F)		<0.1(HS)	0.2	NS(A)				0.2	
	3 (BIR)	0.8	NS	NS(A)	NRS(R)		<0.1(HS)	0.2	0.1				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		<0.1	0.2	NS(A)				0.2	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	<0.1		<0.1(HS)	0.1	<0.1				0.1	0.1
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		<0.1	0.2	0.2				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		<0.1	<0.1					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.1		<0.1(HS)	<0.1					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		<0.1	<0.1					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		<0.1	0.2					NS	0.1
	2 (OF)	NS	NS(A)	NS(A)	0.1		<0.1(HS)	0.1					0.1	0.1
	3 (BIR)	NS	NS(A)	NS(A)	0.1		<0.1	<0.1					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	0.4	0.2					NS	<0.1			
	2 (OF)	NS(A)	NS(A)	0.1	NS(A)					NS	NS(A)			
	3 (BIR)	<0.1	NS(A)	0.4	0.1					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	0.2	0.2					NS	0.1			
	2 (OF)	NS(A)	NS(A)	0.2	NS(A)					<0.1	NS(A)			
	3 (BIR)	NS(A)	NS(A)	0.2	0.1					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				<0.1		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				<0.1		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	<0.1	<0.1				0.2		0.2		
	3 (BIR)	--	--	NS(A)	0.1	0.1				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				<0.1		0.1		
	3 (BIR)	--	--	NS(A)	<0.1	NS(A)				NS		0.3		

BARIUM (mg/l)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	<0.2	<0.3	<0.1	<0.1	0.2		<0.1					0.1 (V(M))
	2'	NS	<0.2	<0.3	0.1	NS	NS(A)		0.1					<0.1
	6'	NS	<0.2	<0.3	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	0.3	<0.3	<0.1	NS	<0.1	0.2						<0.1	
	2'	0.8(HS)	NS(A)	ISP	NS	<0.1	NS(A)						NS	
	6'	0.3(V)	<0.3	0.1	NS	<0.1	NS(A)						<0.1	
L3	6"	NS(A)	NS(A)	0.1	0.1				<0.1		NS			
	2'	NS(A)	NS(A)	<0.1	NS(A)				IS		NS			
	6'	NS(A)	NS(A)	0.1	<0.1				0.1		0.1			
L4	6"	NS	0.1	NS(A)	NS(A)			<0.1		NS		0.2		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			0.1		NS		0.1		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

BARIUM (mg/l)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		<0.1 (US(D))		<0.1 (US)
Water from government test well	<0.1		0.2	
Water from #5 deep well	<0.1		0.1	

BERYLLIUM (mg/1)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	<0.01	<0.01	NS(A)	NRS(F)		0.02(HS)	<0.01	<0.01				NS	
	2 (OF)	<0.01	<0.01	NS(A)	NRS(F)		0.02	<0.01	NS(A)				<0.01	
	3 (BIR)	<0.01	NS	NS(A)	NRS(R)		0.02(HS)	<0.01	<0.01				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		0.03	<0.01	NS(A)				<0.01	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	<0.02		0.03(HS)	<0.01	<0.01				0.01	<0.01
	3 (BIP)	NS	NS(A)	NS(A)	NS(A)		0.03	<0.01	<0.01				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		0.03	<0.01					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	<0.02		0.02(HS)	<0.01					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		<0.01	<0.01					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		<0.01	<0.01					NS	<0.01
	2 (OF)	NS	NS(A)	NS(A)	<0.02		<0.01(HS)	<0.01					<0.01	<0.01
	3 (BIR)	NS	NS(A)	NS(A)	<0.02		0.04	<0.01					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	<0.01	<0.01					NS	<0.01			
	2 (OF)	NS(A)	NS(A)	<0.01	NS(A)					NS	NS(A)			
	3 (BIR)	0.03	NS(A)	<0.01	<0.01					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	<0.01	<0.01					NS	<0.01			
	2 (OF)	NS(A)	NS(A)	<0.01	NS(A)					<0.01	NS(A)			
	3 (BIR)	NS(A)	NS(A)	<0.01	<0.01					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				<0.01		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.01		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	<0.01	<0.01				<0.01		<0.01		
	3 (BIR)	--	--	NS(A)	<0.01	<0.01				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				<0.01		<0.01		
	3 (BIR)	--	--	NS(A)	<0.01	NS(A)				NS		<0.01		

BERYLLIUM (mg/1)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	<0.01	<0.01	<0.02	0.02	<0.01		<0.01					<0.01 (V(M))
	2'	NS	<0.01	IS	<0.02	NS	NS(A)		<0.01					<0.01
	6'	NS	<0.01	<0.01	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	<0.01	<0.01	<0.02	NS	<0.01	<0.01						<0.01	
	2'	<0.01(HS)	NS(A)	ISP	NS	0.02	NS(A)						NS	
	6'	<0.01(V)	<0.01	<0.02	NS	0.03	NS(A)						<0.01	
L3	6"	NS(A)	NS(A)	<0.01	<0.01				<0.01		NS			
	2'	NS(A)	NS(A)	<0.01	NS(A)				IS		NS			
	6'	NS(A)	NS(A)	<0.01	<0.01				<0.01		<0.01			
L4	6"	NS	<0.01	NS(A)	NS(A)			<0.01		NS		0.01		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			<0.01		NS		<0.01		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

BERYLLIUM (mg/1)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		<0.1 (US(D))		<0.01 (US)
Water from government test well	<0.2		<0.1	
Water from #5 deep well	<0.2		<0.1	

BORON (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	<0.1	<0.1	NS(A)	NRS(F)		2.5(HS)	1.1	1.6				NS	
	2 (OF)	8.2	<0.1	NS(A)	NRS(F)		0.5(HS)	1.9	NS(A)				0.8	
	3 (BIR)	<0.1	NS	NS(A)	NRS(R)		1.1(HS)	0.8	0.6				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		1.8	3.5	NS(A)				4.4	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.2		2.2(HS)	8.6	3.9				3.0	4.6
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		1.2	2.4	2.5				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		1.2	0.4					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.6		2.2(HS)	9.4					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		2.7	1.1					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		3.0	10.4					NS	1.7
	2 (OF)	NS	NS(A)	NS(A)	2.5		1.6(HS)	7.5					2.3	1.1
	3 (BIR)	NS	NS(A)	NS(A)	IS		1.3	0.5					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	3.6	5.4					NS	5.2			
	2 (OF)	NS(A)	NS(A)	10.1	NS(A)					NS	NS(A)			
	3 (BIR)	9.1	NS(A)	11.8	5.5					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	10.7	7.6					NS	5.8			
	2 (OF)	NS(A)	NS(A)	10.8	NS(A)					<0.1	NS(A)			
	3 (BIR)	NS(A)	NS(A)	10.4	7.7					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				0.6		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				2.5		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	<0.1	0.9				0.6		1.6		
	3 (BIR)	--	--	NS(A)	2.7	6.5				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				2.1		0.3		
	3 (BIR)	--	--	NS(A)	6.5	NS(A)				NS		6.7		

BORON (mg/l)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	4.3	5.7	5.6	4.2	4.7		2.4					3.1 (V(M))
	2'	NS	1.1	IS	IS	NS	NS(A)		4.1					2.3
	6'	NS	2.3	4.9	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	0.4	4.1	5.0	NS	3.1	2.9				NS		3.9	
	2'	1.5(HS)	NS(A)	ISP	NS	0.7	NS(A)				NS		NS	
	6'	<0.1(V)	0.2	IS	NS	<0.1	NS(A)				2.2		IS	
L3	6"	NS(A)	NS(A)	1.8	3.0				4.3					
	2'	NS(A)	NS(A)	IS	NS(A)				IS					
	6'	NS(A)	NS(A)	IS	IS				IS					
L4	6"	NS	3.5	NS(A)	NS(A)			4.1		NS		8.0		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			6.8		NS		20.		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

BORON (mg/l)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		0.4 (US(D))		0.1 (US)
Water from government test well	<0.1		<0.1	
Water from #5 deep well	4.1		5.6	

CADMIUM (mg/1)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	0.02	0.01	NS(A)	NRS(F)		0.01(HS)	0.06	0.02				NS	
	2 (OF)	0.02	0.01	NS(A)	NRS(F)		<0.01(HS)	0.05	NS(A)				<0.01	
	3 (BIR)	0.03	NS	NS(A)	NRS(R)		<0.01(HS)	0.06	0.02				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		<0.01	0.06	NS(A)				0.01	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	<0.01		<0.01(HS)	0.09	0.02				0.01	0.01
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		<0.01	0.08	0.02				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		<0.01	0.07					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	<0.01		<0.01(HS)	0.08					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		0.02	0.07					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		0.01	0.10					NS	0.01
	2 (OF)	NS	NS(A)	NS(A)	<0.01		0.02(HS)	0.08					0.01	<0.01
	3 (BIR)	NS	NS(A)	NS(A)	<0.01		0.02	0.08					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	0.19	0.02					NS	0.01			
	2 (OF)	NS(A)	NS(A)	0.10	NS(A)					NS	NS(A)			
	3 (BIR)	<0.01	NS(A)	0.09	0.02					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	0.08	0.02					NS	0.01			
	2 (OF)	NS(A)	NS(A)	0.07	NS(A)					<0.01	NS(A)			
	3 (BIR)	NS(A)	NS(A)	0.08	0.02					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				<0.01		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.01		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	0.02	0.02				0.01		0.01		
	3 (BIR)	--	--	NS(A)	0.03	0.02				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.01		<0.01		
	3 (BIR)	--	--	NS(A)	0.03	NS(A)				NS		0.01		

CADMIUM (mg/1)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	0.02	<0.01	0.01	0.01	0.11		0.02					0.02 (V/(M))
	2'	NS	0.03	0.01	0.01	NS	NS(A)		0.02					0.01
	6'	NS	0.02	<0.01	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	0.02	0.01	0.01	NS	0.01	0.10						0.01	
	2'	0.01(HS)	NS(A)	ISP	NS	<0.01	NS(A)						NS	
	6'	0.02(V)	<0.01	<0.01	NS	<0.01	NS(A)						<0.01	
L3	6"	NS(A)	NS(A)	0.10	0.02				0.01		NS			
	2'	NS(A)	NS(A)	0.09	NS(A)				0.01		NS			
	6'	NS(A)	NS(A)	0.08	0.03				0.01		0.01			
L4	6"	NS	0.10	NS(A)	NS(A)			0.01		NS		0.01		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			0.01		NS		<0.01		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

CADMIUM (mg/1)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		0.06 (US(D))		<0.01 (US)
Water from government test well	<0.01		0.08	
Water from #5 deep well	<0.01		0.07	

CALCIUM (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	1420	760	NS(A)	NRS(F)		164(HS)	512	651				NS	
	2 (OF)	880	436	NS(A)	NRS(F)		366(HS)	405	NS(A)				234	
	3 (BIR)	1400	NS	NS(A)	NRS(R)		190(HS)	630	620				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		210	688	NS(A)				554	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	278		160(HS)	121	245				342	631
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		148	587	549				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		136	83					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	277		155(HS)	114					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		827	49					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		112	579					NS	341
	2 (OF)	NS	NS(A)	NS(A)	368		156(HS)	119					409	51
	3 (BIR)	NS	NS(A)	NS(A)	72		118	15.8					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	313	486					NS	544			
	2 (OF)	NS(A)	NS(A)	119	NS(A)					NS	NS(A)			
	3 (BIR)	396	NS(A)	494	469					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	122	495					NS	665			
	2 (OF)	NS(A)	NS(A)	117	NS(A)					33	NS(A)			
	3 (BIR)	NS(A)	NS(A)	299	452					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				25		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				588		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	245	420				404		694		
	3 (BIR)	--	--	NS(A)	524	515				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				402		68		
	3 (BIR)	--	--	NS(A)	587	NS(A)				NS		545		

CALCIUM (mg/l)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	805	890	771	643	719		627					554 (V(M)) (402) (615) (639)
	2'	NS	406	450	362	NS	NS(A)		422					291
	6'	NS	739	825	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	429	515	636	NS	555	638						658	
	2'	322(HS)	NS(A)	ISP	NS	379	NS(A)						NS	
	6'	129(V) (14)	19	12.5	NS	47	NS(A)						60	
L3	6"	NS(A)	NS(A)	174	260				424		NS			
	2'	NS(A)	NS(A)	275	NS(A)				384		NS			
	6'	NS(A)	NS(A)	115	267				246		219			
L4	6"	NS	352	NS(A)	NS(A)			518		NS		518		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			538		NS		544		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

CALCIUM (mg/l)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		45 (US(D))		9.4 (US)
Water from government test well	9		110	
Water from #5 deep well	168		132	

CARBONATE (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day
S1	1 (BOR)	10	7	NS(A)	NRS(F)		<1(HS)	<1	<1
	2 (OF)	8	2	NS(A)	NRS(F)		<1(HS)	<1	NS(A)
	3 (BIR)	10	NS	NS(A)	NRS(R)		<1(HS)	<1	<1
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		<1	<1	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	<1		<1(HS)	<1	<1
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		<1	<1	<1
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		<1	<1	
	2 (OF)	NS	NS(A)	NS(A)	<1		<1(HS)	<1	
	3 (BIR)	NS	NS(A)	NS(A)	NS		<1	Acid	
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		<1	<1	
	2 (OF)	NS	NS(A)	NS(A)	<1		<1(HS)	<1	
	3 (BIR)	NS	NS(A)	NS(A)	IS		<1	Acid	
S5	1 (BOR)	NS(A)	NS(A)	<1	<1				
	2 (OF)	NS(A)	NS(A)	<1	NS(A)				
	3 (BIR)	<1	NS(A)	<1	<1				
S6	1 (BOR)	NS(A)	NS(A)	<1	<1				
	2 (OF)	NS(A)	NS(A)	<1	NS(A)				
	3 (BIR)	NS(A)	NS(A)	<1	<1				
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)			
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)			
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	<1	<1			
	3 (BIR)	--	--	NS(A)	<1	<1			
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)			
	3 (BIR)	--	--	NS(A)	<1	NS(A)			

NOTE: For those samples designated "Acid", only an (hydrochloric acid- or nitric acid-) acidified sample was submitted for analysis. Acidification of a solution containing carbonate (or bicarbonate) results in the formation of carbonic acid, which dissociates (in part) to water and carbon dioxide, which is liberated (in part), as a gas. Since carbonic acid exists (in typical leachate solutions) in equilibrium with bicarbonate, acidification of a solution containing carbonic acid also effects the liberation of carbon dioxide. In all cases, meaningful values for these samples are not available.

BEGIN LAST LINE OF TEXT
BOTTOM OF IMAGE AREA; OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
3/8"
PAGE NUMBER

CARBONATE (mg/l)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	360 Day
L1	6"	NS	<1	Acid	<1	<1	<1	<1
	2'	NS	<1	Acid	Acid	NS	NS(A)	IS
	6'	NS	<1	Acid	ISP	ISP	NS(A)	NS(A)
L2	6"	<1	<1	<1	NS	<1	<1	
	2'	<1(HS)	NS(A)	ISP	NS	Acid	NS(A)	
	6'	Acid(V) <1	<1	Acid	NS	Acid	NS(A)	
L3	6"	NS(A)	NS(A)	<1	<1			
	2'	NS(A)	NS(A)	IS	NS(A)			
	6'	NS(A)	NS(A)	IS	IS			
L4	6"	NS	Acid	NS(A)	NS(A)			
	2'	NS	NS(A)	NS(A)	NS(A)			
	6'	NS	NS(A)	NS(A)	NS(A)			
L5	6"	NS	NS(A)	NS(A)	NS(A)			
	2'	NS	NS(A)	NS(A)	NS(A)			
	6'	NS	NS(A)	NS(A)	NS(A)			

CARBONATE (mg/l)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77
Rainwater		IS	
Water from government test well	3		<1
Water from #5 deep well	<1		<1

NOTE: For those samples designated "Acid", only an (hydrochloric acid-or nitric acid-) acidified sample was submitted for analysis. Acidification of a solution containing carbonate (or bicarbonate) results in the formation of carbonic acid, which dissociates (in part) to water and carbon dioxide, which is liberated (in part), as a gas. Since carbonic acid exists (in typical leachate solutions) in equilibrium with bicarbonate, acidification of a solution containing carbonic acid also effects the liberation of carbon dioxide. In all cases, meaningful values for these samples are not available.

BICARBONATE (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day
S1	1 (BOR)	<1	<1	NS(A)	NRS(F)		250(HS)	67	2
	2 (OF)	2	1	NS(A)	NRS(F)		63(HS)	31	NS(A)
	3 (BIR)	<1	NS	NS(A)	NRS(R)		189(HS)	32	25
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		80	1	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	48		147(HS)	57	45
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		95	51	45
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		20	13	
	2 (OF)	NS	NS(A)	NS(A)	29		77(HS)	69	
	3 (BIR)	NS	NS(A)	NS(A)	NS		2	Acid	
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		14	69	
	2 (OF)	NS	NS(A)	NS(A)	74		79(HS)	79	
	3 (BIR)	NS	NS(A)	NS(A)	IS		40	Acid	
S5	1 (BOR)	NS(A)	NS(A)	62	60				
	2 (OF)	NS(A)	NS(A)	84	NS(A)				
	3 (BIR)	54	NS(A)	63	66				
S6	1 (BOR)	NS(A)	NS(A)	91	62				
	2 (OF)	NS(A)	NS(A)	95	NS(A)				
	3 (BIR)	NS(A)	NS(A)	63	67				
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)			
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)			
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	90	19			
	3 (BIR)	--	--	NS(A)	4	32			
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)			
	3 (BIR)	--	--	NS(A)	37	NS(A)			

See "Note" under "Carbonate (S Impoundments)"

BICARBONATE (mg/1)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	360 Day
L1	6"	NS	54	Acid	130	107	42	43
	2'	NS	<1	Acid	Acid	NS	NS(A)	IS
	6'	NS	<1	Acid	ISP	ISP	NS(A)	NS(A)
L2	6"	11	1	<1	NS	<1	8	
	2'	<1(NS)(A)	NS(A)	ISP	NS	Acid	NS(A)	
	6'	Acid(V) (17)	17	Acid	NS	Acid	NS(A)	
L3	6"	NS(A)	NS(A)	<1	<1			
	2'	NS(A)	NS(A)	IS	NS(A)			
	6'	NS(A)	NS(A)	IS	IS			
L4	6"	NS	Acid	NS(A)	NS(A)			
	2'	NS	NS(A)	NS(A)	NS(A)			
	6'	NS	NS(A)	NS(A)	NS(A)			
L5	6"	NS	NS(A)	NS(A)	NS(A)			
	2'	NS	NS(A)	NS(A)	NS(A)			
	6'	NS	NS(A)	NS(A)	NS(A)			

BICARBONATE (mg/1)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77
Rainwater		IS	
Water from government test well	83		190
Water from #5 deep well	38		36

See "Note" under "Carbonate (L Impoundments)"

CARBONIC ACID (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day
S1	1 (BOR)	<1	<1	NS(A)	NRS(F)		31(HS)	46	57
	2 (OF)	<1	<1	NS(A)	NRS(F)		12(HS)	15	NS(A)
	3 (BIR)	<1	NS	NS(A)	NRS(R)		45(HS)	15	21
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		19	1	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	9		18(HS)	14	30
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		18	12	30
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		51	6	
	2 (OF)	NS	NS(A)	NS(A)	20		59(HS)	25	
	3 (BIR)	NS	NS(A)	NS(A)	NS		20	Acid	
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		30	7	
	2 (OF)	NS	NS(A)	NS(A)	14		68(HS)	21	
	3 (BIR)	NS	NS(A)	NS(A)	15		27	Acid	
S5	1 (BOR)	NS(A)	NS(A)	17	14				
	2 (OF)	NS(A)	NS(A)	30	NS(A)				
	3 (BIR)	4	NS(A)	12	11				
S6	1 (BOR)	NS(A)	NS(A)	22	10				
	2 (OF)	NS(A)	NS(A)	26	NS(A)				
	3 (BIR)	NS(A)	NS(A)	22	8				
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)			
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)			
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	24	13			
	3 (BIR)	--	--	NS(A)	103	11			
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)			
	3 (BIR)	--	--	NS(A)	9	NS(A)			

See "Note" under "Carbonate (S Impoundments)"

CHLORIDE (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	830	740	NS(A)	NRS(F)		116(HS)	460	470				NS	
	2 (OF)	1040	288	NS(A)	NRS(F)		33(HS)	50	NS(A)				24.6	
	3 (BIR)	800	NS	NS(A)	NRS(R)		62(HS)	315	258				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		100	239	NS(A)				27.8	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	10.2		95(HS)	115	50				17.4	35
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		82	153	120				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		88	9.5					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	7.0		108(HS)	110					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		615	HCl					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		94	350					NS	1.6
	2 (OF)	NS	NS(A)	NS(A)	6.8		82(HS)	117					1.0	50
	3 (BIR)	NS	NS(A)	NS(A)	1.6		79	HCl					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	115	115					NS	1.8			
	2 (OF)	NS(A)	NS(A)	153	NS(A)					NS	NS(A)			
	3 (BIR)	57	NS(A)	73	122					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	136	112					NS	5.2			
	2 (OF)	NS(A)	NS(A)	131	NS(A)					2.5	NS(A)			
	3 (BIR)	NS(A)	NS(A)	137	116					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				2.4		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				2.6		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	5.0	3.0				2.4		6.6		
	3 (BIR)	--	--	NS(A)	12.1	135				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				3.1		3.0		
	3 (BIR)	--	--	NS(A)	93	NS(A)				NS		156		

NOTE: For those samples designated "HCl", only a hydrochloric acid-acidified sample was submitted for analysis. Meaningful chloride values are therefore unavailable.

CARBONIC ACID (mg/1)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	360 Day
L1	6"	NS	26	Acid	31	31	8	29
	2'	NS	9	Acid	Acid	NS	NS(A)	IS
	6'	NS	1	Acid	ISP	ISP	NS(A)	NS(A)
L2	6"	40	6	<1	NS	2	8	
	2'	<1(HS)	NS(A)	ISP	NS	Acid	NS(A)	
	6'	Acid(V) (15)	18	Acid	NS	Acid	NS(A)	
L3	6"	NS(A)	NS(A)	8	5			
	2'	NS(A)	NS(A)	IS	NS(A)			
	6'	NS(A)	NS(A)	IS	IS			
L4	6"	NS	Acid	NS(A)	NS(A)			
	2'	NS	NS(A)	NS(A)	NS(A)			
	6'	NS	NS(A)	NS(A)	NS(A)			
L5	6"	NS	NS(A)	NS(A)	NS(A)			
	2'	NS	NS(A)	NS(A)	NS(A)			
	6'	NS	NS(A)	NS(A)	NS(A)			

CARBONIC ACID (mg/1)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77
Rainwater		IS	
Water from government test well	<1		45
Water from #5 deep well	9		7

See "Note" under "Carbonate (L Impoundments)"

CHLORIDE (mg/1)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	768	728	638	510	354		224					22 (V(M))
	2'	NS	593	528	IS	NS	NS(A)		180					15.6
	6'	NS	740	728	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	585	555	531	NS	548	544						536	
	2'	568(HS)	NS(A)	ISP	NS	384	NS(A)						NS	
	6'	130(V) (13)	17	IS	NS	52	NS(A)						14.5	
L3	6"	NS(A)	NS(A)	31	30				25.2		NS			
	2'	NS(A)	NS(A)	43	NS(A)				IS		NS			
	6'	NS(A)	NS(A)	22	28				21.1		21			
L4	6"	NS	HCl	NS(A)	NS(A)			200		NS		275		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			52		NS		74		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

CHLORIDE (mg/1)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		<1 (US(D))		0.9 (US)
Water from government test well	5.8		16	
Water from #5 deep well	29.6		21	

NOTE: For those samples designated "HCl.", only a hydrochloric acid-acidified sample was submitted for analysis. Meaningful chloride values are therefore unavailable.

CHROMIUM (mg/1)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	<0.01	<0.01	NS(A)	NRS(F)		<0.01(HS)	0.02	0.04				NS	
	2 (OF)	<0.01	0.02	NS(A)	NRS(F)		<0.01(HS)	0.03	NS(A)				0.02	
	3 (BIR)	<0.01	NS	NS(A)	NRS(R)		<0.01(HS)	0.02	0.08				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		<0.01	0.01	NS(A)				0.02	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	<0.01		<0.01(HS)	<0.01	0.05				<0.02	0.02
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		<0.01	0.02	0.08				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		<0.01	<0.01					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	<0.01		<0.01(HS)	0.06					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		<0.01	0.02					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		<0.01	0.04					NS	0.02
	2 (OF)	NS	NS(A)	NS(A)	<0.01		<0.01(HS)	0.03					<0.02	0.01
	3 (BIR)	NS	NS(A)	NS(A)	<0.01		<0.01	0.03					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	0.02	0.20					NS	0.02			
	2 (OF)	NS(A)	NS(A)	<0.01	NS(A)					NS	NS(A)			
	3 (BIR)	0.04	NS(A)	0.05	0.25					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	0.10	0.11					NS	0.02			
	2 (OF)	NS(A)	NS(A)	0.13	NS(A)					<0.02	NS(A)			
	3 (BIR)	NS(A)	NS(A)	0.12	0.03					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				<0.02		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				<0.02		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	0.10	0.07				<0.02		0.02		
	3 (BIR)	--	--	NS(A)	0.11	0.11				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				<0.02		<0.01		
	3 (BIR)	--	--	NS(A)	0.24	NS(A)				NS		0.15		

CHROMIUM (mg/l)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	0.01	<0.01	<0.01	<0.01	0.02		0.08					0.02 (V(M))
	2'	NS	<0.01	<0.01	<0.01	NS	NS(A)		<0.01					0.02
	6'	NS	<0.01	<0.01	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	0.02	<0.01	<0.01	NS	<0.01	0.06						0.02	
	2'	<0.01(HS)	NS(A)	ISP	NS	<0.01	NS(A)						NS	
	6'	<0.01(V)	<0.01	<0.01	NS	<0.01	NS(A)						0.03	
L3	6"	NS(A)	NS(A)	0.06	0.09				<0.02		NS			
	2'	NS(A)	NS(A)	0.01	NS(A)				0.03		NS			
	6'	NS(A)	NS(A)	<0.01	<0.01				<0.03		0.01			
L4	6"	NS	0.08	NS(A)	NS(A)			0.03		NS		0.02		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			0.02		NS		0.01		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

CHROMIUM (mg/l)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		0.03 (US(D))		<0.01 (US)
Water from government test well	<0.01		0.09	
Water from #5 deep well	<0.01		0.06	

CONDUCTIVITY (μmho/cm)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	10030	7670	NS(A)	NRS(F)		1100(HS)	3450	4020				NS	
	2 (OF)	5270	2090	NS(A)	NRS(F)		1450(HS)	1550	NS(A)				Acid	
	3 (BIR)	9630	NS	NS(A)	NRS(R)		985(HS)	3350	3300				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		1150	2850	NS(A)				2060	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	1200		945(HS)	1250	1300				1400	2520
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		840	2500	2080				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		900	430					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	1300		1040(HS)	1150					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		4620	Acid					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		780	3500					NS	1400
	2 (OF)	NS	NS(A)	NS(A)	1550		940(HS)	1000					1490	1050
	3 (BIR)	NS	NS(A)	NS(A)	415		780	Acid					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	2150	3800					NS	2040			
	2 (OF)	NS(A)	NS(A)	1200	NS(A)					NS	NS(A)			
	3 (BIR)	1800	NS(A)	2100	4000					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	1150	3100					NS	2440			
	2 (OF)	NS(A)	NS(A)	1200	NS(A)					142	NS(A)			
	3 (BIR)	NS(A)	NS(A)	2000	3050					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				111		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				2190		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	1150	1450				2110		2240		
	3 (BIR)	--	--	NS(A)	3400	3200				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				1550		572		
	3 (BIR)	--	--	NS(A)	2650	NS(A)				NS		3140		

NOTE: For those samples designated "Acid", only an (hydrochloric acid- or nitric acid-) acidified sample was submitted for analysis. Since the ionic equivalent conductance for hydrogen is much greater than that of most other elements or radicals, the conductivity of an acidified solution does not at all reflect the conductivity of the unacidified solution. Meaningful conductivity values for these samples are therefore unavailable.

CONDUCTIVITY (μmho/cm)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	4600	Acid	4380	3650	3100		2680					1980 (V(M)) (1630) (2320)
	2'	NS	3300	Acid	Acid	NS	NS(A)		2400					1430
	6'	NS	3610	Acid	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	2840	3130	3730	NS	3580	3350						3840	
	2'	2950(HS)	NS(A)	ISP	NS	Acid	NS(A)						NS	
	6'	Acid(V) (220)	225	Acid	NS	Acid	NS(A)						480	
L3	6"	NS(A)	NS(A)	1130	1600				2020		NS			
	2'	NS(A)	NS(A)	1520	NS(A)				1670		NS			
	6'	NS(A)	NS(A)	850	1550				1360		1360			
L4	6"	NS	Acid	NS(A)	NS(A)			3320		NS		3370		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			2680		NS		2640		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

CONDUCTIVITY (μmho/cm)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		250 (US(D))		50.3 (US)
Water from government test well	141		670	
Water from #5 deep well	921		720	

NOTE: For those samples designated "Acid", only an (hydrochloric acid- or nitric acid) acidified sample was submitted for analysis. Since the ionic equivalent conductance for hydrogen is much greater than that of most other elements or radicals, the conductivity of an acidified solution does not at all reflect the conductivity of the unacidified solution. Meaningful conductivity values for these samples are therefore unavailable.

EPA Form 2350-4 (4-80)
(PREVIOUSLY C.H. EPA FORM 781)
TYPING GUIDE SHEET

COPPER (mg/1)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	<0.03	<0.03	NS(A)	NRS(F)		<0.02(HS)	0.04	0.19				NS	
	2 (OF)	0.09	<0.03	NS(A)	NRS(F)		<0.02(HS)	0.02	NS(A)				0.05	
	3 (BIR)	<0.03	NS	NS(A)	NRS(R)		<0.02(HS)	0.05	0.18				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		<0.02	0.06	NS(A)				0.02	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.02		<0.02(HS)	0.07	0.18				<0.02	0.04
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		<0.02	0.08	0.19				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		0.06	0.06					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	<0.03		0.02(HS)	0.07					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		0.04	0.05					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		0.02	0.03					NS	0.02
	2 (OF)	NS	NS(A)	NS(A)	<0.03		0.02(HS)	0.01					0.02	0.02
	3 (BIR)	NS	NS(A)	NS(A)	<0.03		0.02	0.03					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	0.05	0.03					NS	0.02			
	2 (OF)	NS(A)	NS(A)	0.04	NS(A)					NS	NS(A)			
	3 (BIR)	0.04	NS(A)	0.07	0.02					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	0.05	0.01					NS	0.02			
	2 (OF)	NS(A)	NS(A)	0.04	NS(A)					<0.02	NS(A)			
	3 (BIR)	NS(A)	NS(A)	0.04	0.01					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				<0.02		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.02		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	0.01	0.19				0.02		0.02		
	3 (BIR)	--	--	NS(A)	0.01	0.18				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.02		0.02		
	3 (BIR)	--	--	NS(A)	0.01	NS(A)				NS		0.04		

COPPER (mg/l)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	<0.03	0.02	0.02	0.02	0.06		0.20					0.02 (V(M))
	2'	NS	0.06	<0.02	0.02	NS	NS(A)		0.19					<0.02
	6'	NS	0.06	0.05	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	0.06	0.04	0.04	NS	0.07	0.06						0.02	
	2'	0.03(HS)	NS(A)	ISP	NS	0.04	NS(A)						NS	
	6'	0.03(V) (0.02)	0.04	<0.02	NS	0.02	NS(A)						<0.02	
L3	6"	NS(A)	NS(A)	0.08	0.02				0.03		NS			
	2'	NS(A)	NS(A)	0.07	NS(A)				0.08		NS			
	6'	NS(A)	NS(A)	0.06	0.01				0.04		0.02			
L4	6"	NS	0.05	NS(A)	NS(A)			0.08		NS		0.05		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			0.05		NS		0.04		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

COPPER (mg/l)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		0.04 (US(D))		<0.02 (US)
Water from government test well	<0.02		0.05	
Water from #5 deep well	<0.02		0.05	

FLUORIDE (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	1.01	0.56	NS(A)	NRS(F)		2.20(HS)	0.10	0.15				NS	
	2 (OF)	0.40	0.55	NS(A)	NRS(F)		0.76(HS)	0.66	NS(A)					
	3 (BIR)	0.86	NS	NS(A)	NRS(R)		1.05(HS)	0.12	0.09				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		2.75	5.0	NS(A)				4.5	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.76		2.85(HS)	9.0	3.6				2.8	5.4
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		1.85	3.6	3.3				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		2.15	0.25					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.37		2.50(HS)	7.8					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		0.51	0.44					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		3.25	0.70					NS	1.12
	2 (OF)	NS	NS(A)	NS(A)	0.32		2.70(HS)	7.8					0.90	0.74
	3 (BIR)	NS	NS(A)	NS(A)	0.44		2.70	0.14					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	9.2	0.35					NS	1.48			
	2 (OF)	NS(A)	NS(A)	0.84	NS(A)					NS	NS(A)			
	3 (BIR)	0.68	NS(A)	0.84	0.40					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	8.6	0.28					NS	1.30			
	2 (OF)	NS(A)	NS(A)	5.2	NS(A)					0.17	NS(A)			
	3 (BIR)	NS(A)	NS(A)	9.0	0.22					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				0.07		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.72		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	0.47	0.63				0.69		1.14		
	3 (BIR)	--	--	NS(A)	0.72	0.62				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.70		0.53		
	3 (BIR)	--	--	NS(A)	0.82	NS(A)				NS		0.99		

LAST LINE OF TEXT
BOTTOM OF IMAGE AREA; OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
3/8"

FLUORIDE (mg/l)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	0.21	0.22	0.76	0.11	0.15		0.18					0.08 (V(M))
	2'	NS	0.44	0.32	IS	NS	NS(A)		0.43					0.24
	6'	NS	0.48	0.51	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	0.29	0.66	0.78	NS	0.46	0.29						0.09	
	2'	0.39(HS)	NS(A)	ISP	NS	0.50	NS(A)						NS	
	6'	----(V) (0.28)	0.23	IS	NS	0.10	NS(A)						0.08	
L3	6"	NS(A)	NS(A)	0.56	0.68				0.93		NS			
	2'	NS(A)	NS(A)	0.15	NS(A)				IS		NS			
	6'	NS(A)	NS(A)	IS	0.19				1.07		1.09			
L4	6"	NS	1.05	NS(A)	NS(A)			0.52		NS		1.05		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			0.54		NS		0.32		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

FLUORIDE (mg/l)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		0.24 (US(D))		0.09 (US)
Water from government test well	0.05		0.17	
Water from #5 deep well	0.52		0.56	

IRON (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	0.11	0.03	NS(A)	NRS(F)		≥ 0.25(HS)	0.16	0.25				NS	
	2 (OF)	0.05	0.03	NS(A)	NRS(F)		0.07(HS)	0.03	NS(A)				0.07	
	3 (BIR)	0.05	NS	NS(A)	NRS(R)		≥ 0.12(HS)	0.22	0.27				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		0.04	0.07	NS(A)				0.21	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	<0.02		≥ 0.36(HS)	0.07	0.17				0.16	0.22
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		<0.03	0.19	0.25				NS	NS(A)
S3	1 (BCR)	NS	NS(A)	NS(A)	NS		0.17	0.03					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.04		≥ 0.93(HS)	0.04					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		0.27	0.04					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		<0.01	0.06					NS	0.05
	2 (OF)	NS	NS(A)	NS(A)	0.05		≥ 0.08(HS)	0.04					0.03	0.08
	3 (BIR)	NS	NS(A)	NS(A)	<0.03		0.08	0.03					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	0.03	0.23					NS	<0.03			
	2 (OF)	NS(A)	NS(A)	0.02	NS(A)					NS	NS(A)			
	3 (BIR)	0.04	NS(A)	0.02	0.25					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	0.13	0.24					NS	0.03			
	2 (OF)	NS(A)	NS(A)	0.01	NS(A)					0.04	NS(A)			
	3 (BIR)	NS(A)	NS(A)	0.04	0.24					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				0.04		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.04		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	0.26	0.10				0.09		0.06		
	3 (BIR)	--	--	NS(A)	0.26	0.09				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.04		0.06		
	3 (BIR)	--	--	NS(A)	0.24	NS(A)				NS		0.03		

NOTE: As explained in the preface to this data summary, iron bacteria are believed to be present in those samples designated "HS". Several of the genera which are thought to be present are known to be (in their most developed state) heavily encrusted with iron oxide hydrate. Iron in this agglomerated iron oxide hydrate would only be partially determined by the method used for the determination of iron in the leachates. We have in fact shown that digestion of these samples (in hydrochloric acid) causes a moderate increase in the concentration of iron determined. Consequently, the concentration reported is the concentration obtained after digestion. The concentration of soluble iron in the original leachates (before the conversion of that iron to iron oxide hydrate) is thought to be equal to or greater than the actual concentration determined by the analysis.

IRON (mg/1)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	0.14	0.08	0.06	0.08	0.08		0.13					0.06 (V(M))
	2'	NS	0.11	0.08	0.06	NS	NS(A)		0.13					0.03
	6'	NS	0.05	0.14	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	0.11	0.02	0.23	NS	0.08	0.02						0.03	
	2'	0.08(HS)	NS(A)	ISP	NS	0.05	NS(A)						NS	
	6'	0.05(V) (<0.02)	<0.03	<0.02	NS	<0.01	NS(A)						<0.03	
L3	6"	NS(A)	NS(A)	0.01	0.23				0.03		NS			
	2'	NS(A)	NS(A)	0.01	NS(A)				0.03		NS			
	6'	NS(A)	NS(A)	0.01	0.21				<0.03		0.03			
L4	6"	NS	0.01	NS(A)	NS(A)			0.05		NS		0.09		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			0.06		NS		0.06		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

IRON (mg/1)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		0.18 (US(D))		0.06 (US)
Water from government test well	<0.03		0.02	
Water from #5 deep well	<0.03		0.01	

BEGIN LAST LINE OF TEXT
3/8"
BOTTOM OF IMAGE AREA; OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
PAGE NUMBER

LEAD (mg/1)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	0.018	0.010	NS(A)	NRS(F)		0.002(HS)	0.005	0.006				NS	
	2 (OF)	0.002	0.002	NS(A)	NRS(F)		0.001(HS)	0.001	NS(A)				0.001	
	3 (BIR)	0.019	NS	NS(A)	NRS(R)		<0.001(HS)	0.003	0.008				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		0.002	0.003	NS(A)				0.003	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.001		0.001(HS)	0.002	0.003				<0.001	0.001
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		0.003	0.002	0.004				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		0.001	0.001					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.006		0.003(HS)	0.001					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		0.007	≤0.041(HCl)					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		0.001	0.002					NS	0.001
	2 (OF)	NS	NS(A)	NS(A)	0.002		0.015(HS)	0.006					0.002	0.003
	3 (BIR)	NS	NS(A)	NS(A)	0.024		0.018	≤0.006(HCl)					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	0.002	0.001					NS	0.001			
	2 (OF)	NS(A)	NS(A)	0.004	NS(A)					NS	NS(A)			
	3 (BIR)	0.001	NS(A)	0.001	0.003					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	0.005	0.001					NS	0.001			
	2 (OF)	NS(A)	NS(A)	0.003	NS(A)					0.002	NS(A)			
	3 (BIR)	NS(A)	NS(A)	0.002	0.001					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				<0.001		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.006		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	<0.001	0.002				0.001		0.002		
	3 (BIR)	--	--	NS(A)	0.001	0.006				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.005		0.001		
	3 (BIR)	--	--	NS(A)	0.001	NS(A)				NS		0.009		

NOTE: For those samples designated "HNO_3", only a nitric acid-acidified sample was submitted for analysis. A comparison of the Pb values determined for those samples where both HNO_3-acidified and unacidified samples were submitted indicates that the values for the HNO_3-acidified samples are much greater than the values for the corresponding unacidified samples. (For the 0 day sample from S1-2(OF) the Pb values are .087 mg/l and .002 mg/l, respectively.) It has not been established whether this discrepancy is a function of the analytical method or if the discrepancy is due to contamination from the HNO_3 used for acidification. In either case, since the validity of the Pb values analytically determined for these samples is in doubt, values for these samples are not reported.

Additionally, it should be noted that if the discrepancy is strictly a function of the high acidity of the sample, then the Pb values for those samples acidified with hydrochloric acid may also be erroneously high. For this reason, in those cases where only HCl-acidified samples were submitted for analysis, the determined value is reported (as a less than or equal to value), but the sample is designated "HCl".

LEAD (mg/1)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	0.007	HNO_3	0.008	0.005	0.005		0.008					0.001 (V(M))
	2'	NS(A)	0.006	HNO_3	HNO_3	NS	NS(A)		0.004					0.002
	6'	NS	0.008	HNO_3	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	0.005	0.007	0.012	NS	0.006	0.005						0.014	
	2'	0.007(HS)	NS(A)	ISP	NS	HNO_3	NS(A)						NS	
	6'	HNO_3(V) (0.001)	0.006	HNO_3	NS	HNO_3	NS(A)						<0.001	
L3	6"	NS(A)	NS(A)	0.009	0.007				0.002		NS			
	2'	NS(A)	NS(A)	0.020	NS(A)				0.006		NS			
	6'	NS(A)	NS(A)	0.002	0.002				0.002		0.002			
L4	6"	NS	≤0.034(HCl)	NS(A)	NS(A)			0.010		NS		0.011		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			0.004		NS		<0.001		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

LEAD (mg/1)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		0.058 (US(T))		0.001 (US)
Water from government test well	<0.001		<0.001	
Water from #5 deep well	<0.001		<0.001	

NOTE: For those samples designated "HNO_3", only a nitric acid-acidified sample was submitted for analysis. A comparison of the Pb values determined for those samples where both HNO_3-acidified and unacidified samples were submitted indicates that the values for the HNO_3-acidified samples are much greater than the values for the corresponding unacidified samples. (For the 0 day sample from S1-2 (OF) the Pb values are .087 mg/l and .002 mg/l, respectively.) It has not been established whether this discrepancy is a function of the analytical method or if the discrepancy is due to contamination from the HNO_3 used for acidification. In either case, since the validity of the Pb values analytically determined for these samples is in doubt, values for these samples are not reported.

Additionally, it should be noted that if the discrepancy is strictly a function of the high acidity of the sample, then the Pb values for those samples acidified with hydrochloric acid may also be erroneously high. For this reason, in those cases where only HCl-acidified samples were submitted for analysis, the determined value is reported (as a less than or equal to value), but the sample is designated "HCl".

MAGNESIUM (mg/1)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	0.16	0.04	NS(A)	NRS(F)		10.0(HS)	1.00	2.52				NS	
	2 (OF)	0.12	1.54	NS(A)	NRS(F)		3.61(HS)	1.35	NS(A)				6.7	
	3 (BIR)	0.03	NS	NS(A)	NRS(R)		2.59(HS)	0.99	1.24				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		12.7	7.5	NS(A)				8.1	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	15.4		11.7(HS)	90	38				5.2	6.5
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		1.71	5.4	5.4				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		13.2	3.09					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	30		13.1(HS)	83					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		18.7	7.8					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		15.7	16.7					NS	0.70
	2 (OF)	NS	NS(A)	NS(A)	26		8.8(HS)	87					1.20	25
	3 (BIR)	NS	NS(A)	NS(A)	6.8		12.5	2.40					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	58	18.4					NS	8.6			
	2 (OF)	NS(A)	NS(A)	93	NS(A)					NS	NS(A)			
	3 (BIR)	1.93	NS(A)	5.2	12.6					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	90	24.4					NS	18			
	2 (OF)	NS(A)	NS(A)	92	NS(A)					1.2	NS(A)			
	3 (BIR)	NS(A)	NS(A)	72	25.6					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				1.05		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				10.9		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	10.1	15.3				8.4		14		
	3 (BIR)	--	--	NS(A)	25.2	20.7				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				6.2		8.9		
	3 (BIR)	--	--	NS(A)	20.3	NS(A)				NS		26		

MAGNESIUM (mg/1)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	1.73	1.90	1.88	1.82	1.57		1.04					1.0 (V(M))
	2'	NS	93	62	89	NS	NS(A)		48					13.7
	6'	NS	9.2	5.5	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	116	142	139	NS	18.5	6.8						10.3	
	2'	104(HS)	NS(A)	ISP	NS	50	NS(A)						NS	
	6'	6.3(V) (3.8)	9.1	11.6	NS	29.3	NS(A)						14.1	
L3	6"	NS(A)	NS(A)	41	50				67		NS			
	2'	NS(A)	NS(A)	85	NS(A)				28		NS			
	6'	NS(A)	NS(A)	56	85				45		56			
L4	6"	NS	82	NS(A)	NS(A)			31		NS		125		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			29		NS		61		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

MAGNESIUM (mg/1)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		1.56 (US(D))		0.10 (US)
Water from government test well	11.2		39	
Water from #5 deep well	9.6		10.7	

MANGANESE (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	0.02	0.01	NS(A)	NRS(F)		1.41(HS)	0.05	0.05				NS	
	2 (OF)	0.01	0.01	NS(A)	NRS(F)		0.14(HS)	0.02	NS(A)				0.11	
	3 (BIR)	0.02	NS	NS(A)	NRS(R)		0.24(HS)	0.05	0.05				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		0.09	0.27	NS(A)				0.04	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.10		0.18(HS)	0.18	0.24				0.11	0.01
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		0.02	0.11	0.05				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		0.07	0.09					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.19		0.91(HS)	0.13					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		4.1	0.67					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		0.05	0.25					NS	0.01
	2 (OF)	NS	NS(A)	NS(A)	0.21		0.04(HS)	0.15					0.02	0.02
	3 (BIR)	NS	NS(A)	NS(A)	0.09		0.03	0.46					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	0.16	0.14					NS	0.01			
	2 (OF)	NS(A)	NS(A)	0.08	NS(A)					NS	NS(A)			
	3 (BIR)	0.03	NS(A)	0.09	1.07					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	0.08	0.06					NS	0.02			
	2 (OF)	NS(A)	NS(A)	0.05	NS(A)					0.06	NS(A)			
	3 (BIR)	NS(A)	NS(A)	0.79	4.2					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				0.15		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.01		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	0.06	0.07				0.11		0.01		
	3 (BIR)	--	--	NS(A)	0.15	0.18				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.12		0.01		
	3 (BIR)	--	--	NS(A)	0.10	NS(A)				NS		0.02		

MANGANESE (mg/1)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	0.29	0.32	0.23	0.26	0.16		0.18					0.06 (V(M))
	2'	NS	4.22	6.7	9.5	NS	NS(A)		4.9					0.71
	6'	NS	4.57	4.5	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	3.97	15.1	15.0	NS	4.3	1.38						0.80	
	2'	5.6(HS)	NS(A)	ISP	NS	8.0	NS(A)						NS	
	6'	1.28(V) (0.08)	0.52	0.29	NS	0.05	NS(A)						0.09	
L3	6"	NS(A)	NS(A)	2.03	2.65				4.2		NS			
	2'	NS(A)	NS(A)	3.26	NS(A)				0.71		NS			
	6'	NS(A)	NS(A)	1.01	2.33				1.91		2.06			
L4	6"	NS	3.10	NS(A)	NS(A)			1.64		NS		2.48		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			0.33		NS		0.26		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

MANGANESE (mg/1)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		0.01(US(D))		0.01(US)
Water from government test well	<0.01		0.22	
Water from #5 deep well	0.20		0.38	

MERCURY (mg/1)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	0.0001	0.0001	NS(A)	NRS(F)		IS	0.0003	0.0001				NS	
	2 (OF)	0.0007	0.0005	NS(A)	NRS(F)		≤0.0001(HS)	0.0001	NS(A)				0.0002	
	3 (BIR)	0.0001	NS	NS(A)	NRS(R)		≤0.0001(HS)	0.0001	0.0001				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		≤0.0003	0.0001	NS(A)				0.0002	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	<0.0001		<0.0002(HS)	0.0002	0.0001				<0.0002	<0.0001
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		<0.0001	<0.0001	0.0002				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		≤0.0004	<0.0001					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	<0.0001		≤0.0003(HS)	0.0003					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		≤0.0004	0.0001					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		0.0002	0.0001					NS	<0.0001
	2 (OF)	NS	NS(A)	NS(A)	<0.0001		0.0002(HS)	0.0004					0.0001	<0.0005 (IS)
	3 (BIR)	NS	NS(A)	NS(A)	<0.0001		0.0001	0.0001					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	0.0004	0.0003					NS	<0.0001			
	2 (OF)	NS(A)	NS(A)	0.0004	NS(A)					NS	NS(A)			
	3 (BIR)	0.0006	NS(A)	0.0002	0.0001					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	0.0004	0.0001					NS	<0.0001			
	2 (OF)	NS(A)	NS(A)	0.0002	NS(A)					<0.0002	NS(A)			
	3 (BIR)	NS(A)	NS(A)	0.0004	<0.0001					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				<0.0001		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.0001		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	0.0001	0.0004				0.0004		<0.0002		
	3 (BIR)	--	--	NS(A)	0.0001	0.0002				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.0001		<0.0001		
	3 (BIR)	--	--	NS(A)	0.0001	NS(A)				NS		0.0001		

MERCURY (mg/1)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	0.0002	<0.0001	<0.0001	IS	0.0002		0.0002					0.0003 (V(M))
	2'	NS	0.0001	0.0001	0.0001	NS	NS(A)		IS					0.0003
	6'	NS	0.0001	0.0002	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	0.0003	0.0005	0.0001	NS	<0.0002	0.0003						0.0002	
	2'	0.0001(HS)	NS(A)	ISP	NS	0.0002	NS(A)						NS	
	6'	0.0002(V)	<0.0001	<0.0001	NS	0.0002	NS(A)						<0.0001	
L3	6"	NS(A)	NS(A)	0.0002	0.0001				0.0001		NS			
	2'	NS(A)	NS(A)	IS	NS(A)				IS		NS			
	6'	NS(A)	NS(A)	IS	IS				0.0002		<0.0005 (IS)			
L4	6"	NS	0.0004	NS(A)	NS(A)			0.0001		NS		0.0001		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			<0.0001		NS		<0.0001		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

MERCURY (mg/1)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		0.0002(US(T))		0.0001
Water from government test well	<0.0001		0.0001	
Water from #5 deep well	<0.0001		<0.0001	

NICKEL (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	0.09	<0.04	NS(A)	NRS(F)		<0.04(HS)	0.18	0.17				NS	
	2 (OF)	0.13	<0.04	NS(A)	NRS(F)		<0.03(HS)	0.20	NS(A)				0.03	
	3 (BIR)	0.09	NS	NS(A)	NRS(R)		<0.04(HS)	0.21	0.19				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		<0.03	0.19	NS(A)				0.04	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	<0.03		<0.04(HS)	0.23	0.18				0.03	0.05
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		<0.03	0.24	0.19				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		0.03	0.16					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.03		0.05(HS)	0.19					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		0.08	0.27					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		0.03	0.31					NS	0.03
	2 (OF)	NS	NS(A)	NS(A)	0.03		0.05(HS)	0.24					0.03	0.03
	3 (BIR)	NS	NS(A)	NS(A)	0.17		0.05	0.30					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	0.21	0.23					NS	0.05			
	2 (OF)	NS(A)	NS(A)	0.27	NS(A)					NS	NS(A)			
	3 (BIR)	0.05	NS(A)	0.29	0.26					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	0.28	0.26					NS	0.03			
	2 (OF)	NS(A)	NS(A)	0.29	NS(A)					<0.03	NS(A)			
	3 (BIR)	NS(A)	NS(A)	0.27	0.26					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				<0.03		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.03		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	0.27	0.19				0.04		0.05		
	3 (BIR)	--	--	NS(A)	0.27	0.20				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				<0.03		0.03		
	3 (BIR)	--	--	NS(A)	0.28	NS(A)				NS		0.05		

NICKEL (mg/1)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	<0.04	<0.02	0.08	<0.04	0.30		0.20					0.04 (V(M))
	2'	NS	0.84	0.20	0.31	NS	NS(A)		0.30					0.09
	6'	NS	0.09	0.12	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	0.18	0.41	0.36	NS	0.15	0.31						0.13	
	2'	0.31(HS)	NS(A)	ISP	NS	0.18	NS(A)						NS	
	6'	0.13(V) (<0.03)	0.17	<0.03	NS	0.05	NS(A)						0.03	
L3	6"	NS(A)	NS(A)	0.35	0.35				0.17		NS			
	2'	NS(A)	NS(A)	0.40	NS(A)				0.18		NS			
	6'	NS(A)	NS(A)	0.39	0.43				0.14		0.11			
L4	6"	NS	0.38	NS(A)	NS(A)			0.16		NS		0.16		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			0.07		NS		0.05		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

NICKEL (mg/1)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		0.18(US(D))		0.03(US)
Water from government test well	<0.03		0.29	
Water from #5 deep well	<0.03		0.31	

NITRATE (mg/1)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	<1	<1	NS(A)	NRS(F)		Colored	<1	1.0				NS	
	2 (OF)	<1	<1	NS(A)	NRS(F)		<1(HS)	3.5	NS(A)				HNO_3	
	3 (BIR)	<1	NS	NS(A)	NRS(R)		<1(HS)	<1	1.5				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		<1	54	NS(A)				17.8	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	5.4		Colored	<1	<1				5.8	15.3
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		2.5	2.5	19.5				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		<1	<1					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	3.4		<1(HS)	<1					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		21	<1					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		9	3.5					NS	1.8
	2 (OF)	NS	NS(A)	NS(A)	8.5		<1(HS)	<1					0.9	2.4
	3 (BIR)	NS	NS(A)	NS(A)	3.5		<1	<1					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	1	<1					NS	6.1			
	2 (OF)	NS(A)	NS(A)	<1	NS(A)					NS	NS(A)			
	3 (BIR)	<1	NS(A)	7.0	<1					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	<1	<1					NS	0.3			
	2 (OF)	NS(A)	NS(A)	<1	NS(A)					2.3	NS(A)			
	3 (BIR)	NS(A)	NS(A)	<1	<1					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				3.3		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				11.3		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	<1	<1				3.5		8.2		
	3 (BIR)	--	--	NS(A)	<1	<1				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				3.0		0.8		
	3 (BIR)	--	--	NS(A)	<1	NS(A)				NS		0.9		

NOTE: For those samples designated "Colored", the only nitric acid- unacidified samples submitted for analysis were highly colored. In these samples the coloration was such that it produced an unacceptable interference in the colorimetric method by which nitrate is determined in the leachates. Therefore meaningful values for nitrate in these samples is not available.

NOTE: For those samples designated "HNO_3", only a nitric acid-acidified sample was submitted for analysis. Meaningful nitrate values are therefore unavailable.

NITRATE (mg/l)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	<1	HNO_3	2.4	<1	3.0		8.5					21 (V(M))
	2'	NS	1.2	HNO_3	HNO_3	NS	NS(A)		15.5					13.0
	6'	NS	4.5	HNO_3	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	4.0	<1	2.3	NS	<1	2.5						218	
	2'	<1(HS)	NS(A)	ISP	NS	HNO_3	NS(A)						NS	
	6'	HNO_3(V) (25)	22	HNO_3	NS	HNO_3	NS(A)						11.0	
L3	6"	NS(A)	NS(A)	26	10.1				4.9		NS			
	2'	NS(A)	NS(A)	IS	NS(A)				IS		NS			
	6'	NS(A)	NS(A)	12.5	9.5				6.7		11.2			
L4	6"	NS	10.0	NS(A)	NS(A)			2.9		NS		4.5		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			4.5		NS		4.1		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

NITRATE (mg/l)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		1(US(D))		0.4(US)
Water from government test well	<1		2.5	
Water from #5 deep well	2.6		3.0	

NOTE: For those samples designated "HNO_3", only a nitric acid-acidified sample was submitted for analysis. Meaningful nitrate values are therefore unavailable.

NITRITE (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day
S1	1 (BOR)	1.3	1.3	NS(A)	NRS(F)		<0.3(HS)	<0.1	0.1
	2 (OF)	<0.3	1.6	NS(A)	NRS(F)		<0.3(HS)	0.1	NS(A)
	3 (BIR)	1.6	NS	NS(A)	NRS(R)		<0.3(HS)	26.7	0.1
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		<0.3	<0.1	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	2.3		<0.3(HS)	21.3	0.1
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		0.3	2.8	6.8
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		19.4	<0.1	
	2 (OF)	NS	NS(A)	NS(A)	<0.3		3.9(HS)	<0.1	
	3 (BIR)	NS	NS(A)	NS(A)	NS		73.6	--	
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		33.5	0.2	
	2 (OF)	NS	NS(A)	NS(A)	1.3		<0.3(HS)	0.1	
	3 (BIR)	NS	NS(A)	NS(A)	<0.3		17.4	--	
S5	1 (BOR)	NS(A)	NS(A)	0.1	0.1				
	2 (OF)	NS(A)	NS(A)	0.1	NS(A)				
	3 (BIR)	5.9	NS(A)	0.1	0.1				
S6	1 (BOR)	NS(A)	NS(A)	0.1	0.1				
	2 (OF)	NS(A)	NS(A)	<0.1	NS(A)				
	3 (BIR)	NS(A)	NS(A)	<0.1	0.1				
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)			
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)			
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	0.1	0.5			
	3 (BIR)	--	--	NS(A)	0.1	0.1			
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)			
	3 (BIR)	--	--	NS(A)	0.1	NS(A)			

NOTE: The determination of nitrite is not required as part of this project. The analyses were performed in order to confirm and document the effect of a suspected source of interference in the determination of sulfite (which analysis is required). Since the analytical values for nitrite are available (but are not required), they are included in this data summary on an informational-only basis.

Parenthetically, it is added that the procedure by which sulfite is determined in the leachates has been modified to eliminate the interfering effect of nitrite.

NITRITE (mg/l)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	360 Day
L1	6"	NS	0.3	--	1.6	0.3	<0.1	0.5
	2'	NS	0.3	--	--	NS	NS(A)	0.2
	6'	NS	0.7	--	ISP	ISP	NS(A)	NS(A)
L2	6"	0.3	IS	<0.3	NS	<0.3	0.1	
	2'	<0.3(HS)	NS(A)	ISP	NS	--	NS(A)	
	6'	-- (V) (1.0)	<0.3	--	NS	--	NS(A)	
L3	6"	NS(A)	NS(A)	0.1	0.1			
	2'	NS(A)	NS(A)	0.1	NS(A)			
	6'	NS(A)	NS(A)	0.1	0.1			
L4	6"	NS	<0.1	NS(A)	NS(A)			
	2'	NS	NS(A)	NS(A)	NS(A)			
	6'	NS	NS(A)	NS(A)	NS(A)			
L5	6"	NS	NS(A)	NS(A)	NS(A)			
	2'	NS	NS(A)	NS(A)	NS(A)			
	6'	NS	NS(A)	NS(A)	NS(A)			

NITRITE (mg/l)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77
Rainwater		0.2(US(D)	
Water from government test well	<0.3		<0.1
Water from #5 deep well	<0.3		<0.1

NOTE: The determination of nitrite is not required as part of this project. The analyses were performed in order to confirm and document the effect of a suspected source of interference in the determination of sulfite (which analysis is required). Since the analytical values for nitrite are available (but are not required), they are included in this data summary on an informational-only basis.

Parenthetically, it is added that the procedure by which sulfite is determined in the leachates has been modified to eliminate the interfering effect of nitrite.

pH

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	12.2	11.9	NS(A)	NRS(F)		7.3(HS)	6.6	4.8				NS	
	2 (OF)	10.9	10.6	NS(A)	NRS(F)		7.1(HS)	6.7	NS(A)				Acid	
	3 (BIR)	11.9	NS	NS(A)	NRS(R)		7.0(HS)	6.7	6.4				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		7.0	6.2	NS(A)				7.1	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	7.1		7.3(HS)	7.0	6.6				7.1	6.6
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		7.1	7.0	6.6				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		5.9	6.7					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	6.6		6.5(HS)	6.8					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		5.4	Acid					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		6.0	7.4					NS	6.8
	2 (OF)	NS	NS(A)	NS(A)	7.1		6.4(HS)	6.9					7.1	7.6
	3 (BIR)	NS	NS(A)	NS(A)	7.2		6.6	Acid					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	6.9	7.0					NS	7.6			
	2 (OF)	NS(A)	NS(A)	6.8	NS(A)					NS	NS(A)			
	3 (BIR)	7.5	NS(A)	7.1	7.2					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	7.0	7.2					NS	7.1			
	2 (OF)	NS(A)	NS(A)	6.9	NS(A)					6.7	NS(A)			
	3 (BIR)	NS(A)	NS(A)	6.8	7.3					NS	NS(A).			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				5.8		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				7.2		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	6.9	6.6				7.2		7.0		
	3 (BIR)	--	--	NS(A)	5.0	6.8				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				6.7		7.4		
	3 (BIR)	--	--	NS(A)	7.0	NS(A)				NS		6.7		

NOTE: For those samples designated "Acid", only an (hydrochloric acid- or nitric acid-) acidified sample was submitted for analysis. Meaningful pH values for these samples are therefore unavailable.

BEGIN LAST LINE OF TEXT
BOTTOM OF IMAGE AREA, OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
3/8"

pH

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	6.7	Acid	7.0	6.9	7.1		6.6					7.0 (V(M))
	2'	NS	4.3	Acid	Acid	NS	NS(A)		5.3(5.3)					6.0
	6'	NS	5.2	Acid	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	5.8	5.7	5.2	NS	5.0	6.3						6.4	
	2'	4.9(HS)	NS(A)	ISP	NS	Acid(4.9)	NS(A)						NS	
	6'	Acid(V) (6.4)	6.3	Acid	NS	Acid(6.1)	NS(A)						6.3	
L3	6"	NS(A)	NS(A)	4.7	4.7				4.5		NS			
	2'	NS(A)	NS(A)	4.5(4.8)	NS(A)				4.6		NS			
	6'	NS(A)	NS(A)	6.2(6.7)	6.2(7.2)				5.1		5.9			
L4	6"	NS	Acid	NS(A)	NS(A)			4.3		NS		4.4		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			4.5		NS		5.2		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

pH

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		6.2 (US(D))		5.8 (US)
Water from government test well	8.8		7.0	
Water from #5 deep well	7.0		7.1	

NOTE: For those samples designated "Acid", only an (hydrochloric acid- or nitric acid-) acidified sample was submitted for analysis. Meaningful pH values for these samples are therefore unavailable.

NOTE: If the pH of a sample was determined at LG&E before shipment to C-E KDL, the value so determined is inserted parenthetically.

POTASSIUM (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	196	196	NS(A)	NRS(F)		50(HS)	380	430				NS	
	2 (OF)	380	139	NS(A)	NRS(F)		108(HS)	51	NS(A)				46	
	3 (BIR)	305	NS	NS(A)	NRS(R)		36(HS)	370	340				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		34	160	NS(A)				46	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	4.4		20(HS)	21	42				46	42
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		27	140	111				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		31	18					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	7.8		33(HS)	19					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		340	14					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		23	370					NS	3.3
	2 (OF)	NS	NS(A)	NS(A)	14.1		25(HS)	20					3.5	164
	3 (BIR)	NS	NS(A)	NS(A)	0.90		26	2.9					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	190	540					NS	8.9			
	2 (OF)	NS(A)	NS(A)	21	NS(A)					NS	NS(A)			
	3 (BIR)	70	NS(A)	160	680					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	22	330					NS	12.5			
	2 (OF)	NS(A)	NS(A)	22	NS(A)					1.4	NS(A)			
	3 (BIR)	NS(A)	NS(A)	150	340					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				1.4		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				1.4		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	30	27				154		14.1		
	3 (BIR)	--	--	NS(A)	400	450				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				6.7		60		
	3 (BIR)	--	--	NS(A)	200	NS(A)				NS		288		

POTASSIUM (mg/l)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	425	380	382	373	270		200					58 (V(M))
	2'	NS	156	148	105	NS	NS(A)		148					44
	6'	NS	289	336	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	83	44	88	NS	270	330						272	
	2'	61(HS)	NS(A)	ISP	NS	110	NS(A)						NS	
	6'	50(V) (4)	2.1	2.2	NS	3	NS(A)						10.8	
L3	6"	NS(A)	NS(A)	48	55				43		NS			
	2'	NS(A)	NS(A)	57	NS(A)				44		NS			
	6'	NS(A)	NS(A)	9.4	23				28		23			
L4	6"	NS	180	NS(A)	NS(A)			326		NS		194		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			210		NS		154		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

POTASSIUM (mg/l)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		2.0 (US(D))		0.08(US)
Water from government test well	14.8		2.9	
Water from #5 deep well	15.3		13	

SELENIUM (mg/1)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	0.215	0.141	NS(A)	NRS(F)		0.006(HS)	0.003	0.021				NS	
	2 (OF)	0.117	0.060	NS(A)	NRS(F)		0.005(HS)	0.002	NS(A)				<0.001	
	3 (BIR)	0.296	NS	NS(A)	NRS(R)		0.007(HS)	0.003	0.011				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		0.001	<0.001	NS(A)				<0.001	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.007		0.002(HS)	0.001	0.002				<0.001	0.001
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		<0.001	<0.001	0.001				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		0.001	<0.001					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.006		0.002(HS)	<0.001					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		0.005	<0.001					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		0.005	0.016					NS	0.005
	2 (OF)	NS	NS(A)	NS(A)	0.023		0.003(HS)	0.016					0.006	0.001
	3 (BIR)	NS	NS(A)	NS(A)	0.001		0.001	0.001					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	0.006	0.021					NS	0.004			
	2 (OF)	NS(A)	NS(A)	0.011	NS(A)					NS	NS(A)			
	3 (BIR)	0.012	NS(A)	0.004	0.027					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	0.013	0.007					NS	0.004			
	2 (OF)	NS(A)	NS(A)	0.002	NS(A)					<0.001	NS(A)			
	3 (BIR)	NS(A)	NS(A)	0.003	0.006					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				<0.001		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				<0.001		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	<0.001	0.002				<0.002		<0.002		
	3 (BIR)	--	--	NS(A)	0.022	0.015				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.008		<0.001		
	3 (BIR)	--	--	NS(A)	0.020	NS(A)				NS		0.080		

SELENIUM (mg/l)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	0.031	0.038	0.031	0.009	0.017		0.026					<0.001 (V(M))
	2'	NS	0.032	0.019	0.007	NS	NS(A)		0.001					<0.001
	6'	NS	0.062	0.029	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	0.005	0.001	0.007	NS	<0.001	<0.001						<0.001	
	2'	0.005(HS)	NS(A)	ISP	NS	<0.001	NS(A)						NS	
	6'	0.001(V)	0.001	<0.001	NS	<0.001	NS(A)						<0.001	
L3	6"	NS(A)	NS(A)	<0.001	0.005				<0.001		NS			
	2'	NS(A)	NS(A)	<0.001	NS(A)				<0.001		NS			
	6'	NS(A)	NS(A)	<0.001	0.002				<0.001		<0.001			
L4	6"	NS	<0.001	NS(A)	NS(A)			<0.001		NS		0.003		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			<0.001		NS		0.026		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

SELENIUM (mg/l)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		<0.001(US(T))		<0.001(US)
Water from government test well	<0.001		<0.001	
Water from #5 deep well	<0.001		<0.001	

SILVER (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	0.03	<0.03	NS(A)	NRS(F)		0.01(HS)	0.02	0.05				NS	
	2 (OF)	0.03	<0.03	NS(A)	NRS(F)		0.02(HS)	0.01	NS(A)				0.01	
	3 (BIR)	0.05	NS	NS(A)	NRS(R)		0.01(HS)	0.01	0.04				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		0.01	0.01	NS(A)				0.01	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	<0.01		0.01(HS)	0.02	0.03				0.01	0.01
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		0.01	0.01	0.04				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		0.01	0.02					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.01		0.01(HS)	0.01					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		0.03	HCl					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		<0.01	0.01					NS	0.01
	2 (OF)	NS	NS(A)	NS(A)	0.02		0.02(HS)	0.01					0.01	<0.01
	3 (BIR)	NS	NS(A)	NS(A)	0.06		0.01	HCl					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	0.01	0.06					NS	0.01			
	2 (OF)	NS(A)	NS(A)	0.02	NS(A)					NS	NS(A)			
	3 (BIR)	<0.01	NS(A)	0.01	0.05					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	0.02	0.03					NS	0.01			
	2 (OF)	NS(A)	NS(A)	0.01	NS(A)					<0.01	NS(A)			
	3 (BIR)	NS(A)	NS(A)	0.01	0.02					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				0.01		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.01		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	0.03	0.05				<0.01		0.01		
	3 (BIR)	--	--	NS(A)	0.04	0.05				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.01		<0.01		
	3 (BIR)	--	--	NS(A)	0.04	NS(A)				NS		0.01		

NOTE: For those samples designated "HCl", only a hydrochloric acid- acidified sample was submitted for analysis. Since the concentration of soluble chloride alters the concentration of soluble silver, meaningful values for the concentration of silver in these samples are not available.

SILVER (mg/l)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	0.03	0.01	0.02	0.02	0.01		0.04					0.01 (V(M))
	2'	NS	<0.03	0.01	IS	NS	NS(A)		0.03					0.01
	6'	NS	0.03	0.01	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	<0.03	0.01	0.02	NS	0.01	0.01						0.02	
	2'	<0.03(HS)	NS(A)	ISP	NS	<0.01	NS (A)						NS	
	6'	<0.03(V)	<0.01	IS	NS	<0.01	NS (A)						IS	
L3	6"	NS(A)	NS(A)	<0.01	0.04				0.01		NS			
	2'	NS(A)	NS(A)	0.01	NS(A)				0.01		NS			
	6'	NS(A)	NS(A)	0.01	0.03				0.01		0.01			
L4	6"	NS	HCl	NS (A)	NS (A)			0.02		NS		0.01		
	2'	NS	NS (A)	NS (A)	NS (A)			NS		NS		NS		
	6'	NS	NS (A)	NS (A)	NS (A)			NS		NS		NS		
L5	6"	NS	NS (A)	NS (A)	NS (A)			0.02		NS		0.01		
	2'	NS	NS (A)	NS (A)	NS (A)			NS		NS		NS		
	6'	NS	NS (A)	NS (A)	NS (A)			NS		NS		NS		

SILVER (mg/l)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		0.04(US(D))		<0.01(US)
Water from government test well	0.01		0.01	
Water from #5 deep well	0.01		0.01	

NOTE: For those samples designated "HCl", only a hydrochloric acid- acidified sample was submitted for analysis. Since the concentration of soluble chloride alters the concentration of soluble silver, meaningful values for the concentration of silver in these samples are not available.

SODIUM (mg/1)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	289	345	NS(A)	NRS(F)		90(HS)	160	175				NS	
	2 (OF)	226	86	NS(A)	NRS(F)		25(HS)	20	NS(A)				12	
	3 (BIR)	154	NS	NS(A)	NRS(R)		51(HS)	120	117				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		21	70	NS(A)				20	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	5.2		54(HS)	39	18				14	24
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		21	59	47				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		26	5.1					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	7.7		71(HS)	33					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		270	8.4					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		20	260					NS	1.38
	2 (OF)	NS	NS(A)	NS(A)	13.8		40(HS)	34					1.2	36
	3 (BIR)	NS	NS(A)	NS(A)	2.5		20	1.7					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	90	210					NS	2.5			
	2 (OF)	NS(A)	NS(A)	40	NS(A)					NS	NS(A)			
	3 (BIR)	75	NS(A)	96	225					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	39	141					NS	4.7			
	2 (OF)	NS(A)	NS(A)	38	NS(A)					1.4	NS(A)			
	3 (BIR)	NS(A)	NS(A)	90	151					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				1.0		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				3.1		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	10.1	7.4				28		6.4		
	3 (BIR)	--	--	NS(A)	154	164				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				2.9		11.6		
	3 (BIR)	--	--	NS(A)	81	NS(A)				NS		134		

SODIUM (mg/l)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	196	183	190	128	96		84					14 (V(M))
	2'	NS	158	122	128	NS	NS(A)		60					12
	6'	NS	196	174	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	148	200	208	NS	210	150						129	
	2'	132(HS)	NS(A)	ISP	NS	100	NS(A)						NS	
	6'	42(V) (12.1)	13.1	13.2	NS	20	NS(A)						13.4	
L3	6"	NS(A)	NS(A)	28	36				32		NS			
	2'	NS(A)	NS(A)	51	NS(A)				12		NS			
	6'	NS(A)	NS(A)	27	41				23		24			
L4	6"	NS	100	NS(A)	NS(A)			160		NS		206		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			67		NS		90		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

SODIUM (mg/l)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		0.57(US(D))		0.27(US)
Water from government test well	5.9		7.8	
Water from #5 deep well	24		32	

SULFATE (mg/1)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	1173	133	NS(A)	NRS(F)		309(HS)	1483	1880				NS	
	2 (OF)	1649	753	NS(A)	NRS(F)		880(HS)	960	NS(A)				509	
	3 (BIR)	1226	NS	NS(A)	NRS(R)		352(HS)	1880	1840				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		483	1672	NS(A)				1348	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	700		338(HS)	516	693				794	1547
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		277	1450	1380				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		315	215					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	800		388(HS)	480					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		2380	Acid					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		254	1942					NS	769
	2 (OF)	NS	NS(A)	NS(A)	990		364(HS)	496					936	239
	3 (BIR)	NS	NS(A)	NS(A)	206		240	Acid					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	1264	2250					NS	1260			
	2 (OF)	NS(A)	NS(A)	535	NS(A)					NS	NS(A)			
	3 (BIR)	1150	NS(A)	1512	2340					NS	NS(A)			
S5	1 (BOR)	NS(A)	NS(A)	511	1850					NS	1609			
	2 (OF)	NS(A)	NS(A)	530	NS(A)					49	NS(A)			
	3 (BIR)	NS(A)	NS(A)	1188	1730					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				37		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				1420		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	636	1100				1070		1661		
	3 (BIR)	--	--	NS(A)	2130	2060				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				917		184		
	3 (BIR)	--	--	NS(A)	1620	NS(A)				NS		1857		

NOTE: For those samples designated "Acid", only a highly (hydrochloric acid- or nitric acid-) acidified sample was submitted for analysis. At the concentrations which resulted, chloride and nitrate produce unacceptable interferences in the method which is used for the determination of sulfate in the leachates. Since there was insufficient sample for the gravimetric determination of sulfate, meaningful sulfate values for these samples are unavailable.

SULFATE (mg/1)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	630 Day
L1	6"	NS	1420	1940	1810	1620	1785		1680					1265 (V(M)) (1001) (1529)
	2'	NS	975	1020	Acid	NS	NS(A)		1380					798
	6'	NS	1312	1810	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	1065	1459	1910	NS	1654	1686						1477	
	2'	904(HS)	NS(A)	ISP	NS	1110	NS(A)						NS	
	6'	305(V) (23)	57	Acid	NS	<200(Acid)	NS(A)						199	
L3	6"	NS(A)	NS(A)	635	947				1362		NS			
	2'	NS(A)	NS(A)	1185	NS(A)				1120		NS			
	6'	NS(A)	NS(A)	523	990				808		721			
L4	6"	NS	Acid	NS(A)	NS(A)			1920		NS		2043		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			1770		NS		1781		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

SULFATE (mg/1)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		111(US(D))		19(US)
Water from government test well	<1		266	
Water from #5 deep well	436		359	

NOTE: For those samples designated "Acid", only a highly (hydrochloric acid- or nitric acid-) acidified sample was submitted for analysis. At the concentrations which resulted, chloride and nitrate produce unacceptable interferences in the method which is used for the determination of sulfate in the leachates. Since there was insufficient sample for the gravimetric determination of sulfate, meaningful sulfate values for these samples are unavailable.

SULFITE (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day
S1	1 (BOR)	62	29	NS(A)	NRS(F)		3(HS)	2	<1
	2 (OF)	49	14	NS(A)	NRS(F)		<1(HS)	<1	NS(A)
	3 (BIR)	62	NS	NS(A)	NRS(R)		1(HS)	<1	<1
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		1	1	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	<2		<1(HS)	1	<1
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		<1	1	<1
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		<1	<1	
	2 (OF)	NS	NS(A)	NS(A)	1		<1(HS)	<1	
	3 (BIR)	NS	NS(A)	NS(A)	NS		<1	Acid	
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		<1	1	
	2 (OF)	NS	NS(A)	NS(A)	<1		<1(HS)	2	
	3 (BIR)	NS	NS(A)	NS(A)	<1		<1	Acid	
S5	1 (BOR)	NS(A)	NS(A)	2	<1				
	2 (OF)	NS(A)	NS(A)	1	NS(A)				
	3 (BIR)	<1	NS(A)	<1	<1				
S6	1 (BOR)	NS(A)	NS(A)	3	<1				
	2 (OF)	NS(A)	NS(A)	<1	NS(A)				
	3 (BIR)	NS(A)	NS(A)	1	<1				
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)			
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)			
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	<1	<1			
	3 (BIR)	--	--	NS(A)	<1	<1			
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)			
	3 (BIR)	--	--	NS(A)	<1	NS(A)			

NOTE: For those samples designated "Acid", only an (hydrochloric acid- or nitric acid-) acidified sample was submitted for analysis. Acidification of a solution containing sulfite results in the formation of sulfurous acid, which dissociates (in part) to water and sulfur dioxide, which is liberated (in part) as a gas. Consequently, meaningful sulfite values for these samples are not available.

SULFITE (mg/1)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	360 Day
L1	6"	NS	4	Acid	<1	1	1	<1
	2'	NS	4	Acid	Acid	NS	NS(A)	<1
	6'	NS	3	Acid	ISP	ISP	NS(A)	NS(A)
L2	6"	2	9	<1	NS	<1	1	
	2'	3(HS)	NS(A)	ISP	NS	Acid	NS(A)	
	6'	Acid(V) (3)	4	Acid	NS	Acid	NS(A)	
L3	6"	NS(A)	NS(A)	2	<1			
	2'	NS(A)	NS(A)	2	NS(A)			
	6'	NS(A)	NS(A)	1	IS			
L4	6"	NS	Acid	NS(A)	NS(A)			
	2'	NS	NS(A)	NS(A)	NS(A)			
	6'	NS	NS(A)	NS(A)	NS(A)			
L5	6"	NS	NS(A)	NS(A)	NS(A)			
	2'	NS	NS(A)	NS(A)	NS(A)			
	6'	NS	NS(A)	NS(A)	NS(A)			

SULFITE (mg/1)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77
Rainwater		1 (US(T))	
Water from government test well	<1		<1
Water from #5 deep well	<1		<1

NOTE: For those samples designated "Acid", only an (hydrochloric acid- or nitric acid-) acidified sample was submitted for analysis. Acidification of a solution containing sulfite results in the formation of sulfurous acid, which dissociates (in part) to water and sulfur dioxide, which is liberated (in part), as a gas. Consequently, meaningful sulfite values for these samples are not available.

TOTAL DISSOLVED SOLIDS (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day		30 Day		60 Day		90 Day		120 Day		180 Day		270 Day	
		105°C	590°C	105°C	590°C	105°C	590°C	105°C	590°C	105°C	590°C	105°C	590°C	105°C	590°C
S1	1 (BOR)	5140	4790	3090	2960	NS(A)	NS(A)	NRS(F)	NRS(F)			990(HS)	770(HS)	3220	2890
	2 (OF)	4670	4330	1860	1780	NS(A)	NS(A)	NRS(F)	NRS(F)			1560(HS)	1410(HS)	1760	1450
	3 (BIR)	5120	4630	NS	NS	NS(A)	NS(A)	NRS(R)	NRS(R)			930(HS)	720(HS)	3610	3340
S2	1 (BOR)	NS	NS	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)			1060	910	3240	2880
	2 (OF)	NS	NS	NS(A)	NS(A)	NS(A)	NS(A)	1180	1070			820(HS)	690(HS)	1060	900
	3 (BIR)	NS	NS	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)			740	640	2891	2470
S3	1 (BOR)	NS	NS	NS(A)	NS(A)	NS(A)	NS(A)	NS	NS			760	660	350	310
	2 (OF)	NS	NS	NS(A)	NS(A)	NS(A)	NS(A)	1280	1150			900(HS)	800(HS)	1054	850
	3 (BIR)	NS	NS	NS(A)	NS(A)	NS(A)	NS(A)	NS	NS			5100	4800	Acid	Acid
S4	1 (BOR)	NS	NS	NS(A)	NS(A)	NS(A)	NS(A)	NS	NS			700	580	3890	3620
	2 (OF)	NS	NS	NS(A)	NS(A)	NS(A)	NS(A)	1620	1450			820(HS)	710(HS)	1095	870
	3 (BIR)	NS	NS	NS(A)	NS(A)	NS(A)	NS(A)	344	314			670	580	Acid	Acid
S5	1 (BOR)	NS(A)	NS(A)	NS(A)	NS(A)	2310	2080	3960	3740						
	2 (OF)	NS(A)	NS(A)	NS(A)	NS(A)	1141	940	NS(A)	NS(A)						
	3 (BIR)	1890	1700	NS(A)	NS(A)	2630	2440	4140	3920						
S6	1 (BOR)	NS(A)	NS(A)	NS(A)	NS(A)	1143	920	3200	3010						
	2 (OF)	NS(A)	NS(A)	NS(A)	NS(A)	1185	930	NS(A)	NS(A)						
	3 (BIR)	NS(A)	NS(A)	NS(A)	NS(A)	2210	1950	3080	2920						
S7	1 (BOR)	--	--	--	--	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)				
	2 (OF)	--	--	--	--	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)				
	3 (BIR)	--	--	--	--	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)				
S8	1 (BOR)	--	--	--	--	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)				
	2 (OF)	--	--	--	--	NS(A)	NS(A)	1050	960	1780	1640				
	3 (BIR)	--	--	--	--	NS(A)	NS(A)	3690	3460	3660	3470				
S9	1 (BOR)	--	--	--	--	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)				
	2 (OF)	--	--	--	--	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)				
	3 (BIR)	--	--	--	--	NS(A)	NS(A)	2750	2570	NS(A)	NS(A)				

NOTE: For those samples designated "Acid", only a highly (hydrochloric acid- or nitric acid-) acidified sample was submitted for analysis. Since the total dissolved solids determined for these samples would have indicated a TDS concentration not representative of the leachate as-sampled, the total dissolved solids were not determined for these samples, and TDS values for these samples are therefore unavailable.

TOTAL DISSOLVED SOLIDS (mg/l)

(S IMPOUNDMENTS)

Site	Zone	360 Day		390 Day		450 Day		480 Day		630 Day		660 Day	
		105°C	590°C	105°C	590°C	105°C	590°C	105°C	590°C	105°C	590°C	105°C	590°C
S1	1 (BOR)	3970	3560							NS	NS		
	2 (OF)	NS(A)	NS(A)							Acid	Acid		
	3 (BIR)	3530	3290							NS	NS		
S2	1 (BOR)	NS(A)	NS(A)							2240	2040	NS(A)	NS(A)
	2 (OF)	1320	1140							1380	1220	2580	2350
	3 (BIR)	2490	2290							NS	NS	NS(A)	NS(A)
S3	1 (BOR)									NS	NS	NS(A)	NS(A)
	2 (OF)									NS	NS	NS(A)	NS(A)
	3 (BIR)									NS	NS	NS(A)	NS(A)
S4	1 (BOR)									NS	NS	1270	1160
	2 (OF)									1510	1360	880	640
	3 (BIR)									NS	NS	NS(A)	NS(A)
S5	1 (BOR)			NS	NS	2080	1890						
	2 (OF)			NS	NS	NS(A)	NS(A)						
	3 (BIR)			NS	NS	NS(A)	NS(A)						
S6	1 (BOR)			NS	NS	2610	2370						
	2 (OF)			94	72	NS(A)	NS(A)						
	3 (BIR)			NS	NS	NS(A)	NS(A)						
S7	1 (BOR)			70	48			NS(A)	NS(A)				
	2 (OF)			2210	2010			NS(A)	NS(A)				
	3 (BIR)			NS	NS			NS(A)	NS(A)				
S8	1 (BOR)			NS	NS			NRS(R)	NRS(R)				
	2 (OF)			1990	1740			2710	2450				
	3 (BIR)			NS	NS			NS(A)	NS(A)				
S9	1 (BOR)			NS	NS			NS(A)	NS(A)				
	2 (OF)			1490	1350			460	380				
	3 (BIR)			NS	NS			3530	3100				

TOTAL DISSOLVED SOLIDS (mg/1)

(L IMPOUNDMENTS)

Site	Zone	0 Day 105°C	0 Day 590°C	30 Day 105°C	30 Day 590°C	60 Day 105°C	60 Day 590°C	90 Day 105°C	90 Day 590°C	180 Day 105°C	180 Day 590°C	270 Day 105°C	270 Day 590°C	300 Day 105°C	300 Day 590°C
L1	6"	NS	NS	4230	3950	Acid(4155)	Acid	4240	3910	4020	3380	3580	3360		
	2'	NS	NS	2930	2330	Acid(2326)	Acid	Acid	Acid	NS	NS	NS(A)	NS(A)		
	6'	NS	NS	3110	2880	Acid(3908)	Acid	ISP	ISP	ISP	ISP	NS(A)	NS(A)		
L2	6"	2640	2010	3310	2620	4060	3430	NS	NS	3340	3000	3670	3330		
	2'	2440(HS)	1630(HS)	NS(A)	NS(A)	ISP	ISP	NS	NS	Acid(2068)	Acid	NS(A)	NS(A)		
	6'	Acid(662)(V)	Acid(V)	193	144	Acid	Acid	NS	NS	Acid(≤351)	Acid	NS(A)	NS(A)		
L3	6"	NS(A)	NS(A)	NS(A)	NS(A)	1100	970	1570	1410						
	2'	NS(A)	NS(A)	NS(A)	NS(A)	2010	1790	NS(A)	NS(A)						
	6'	NS(A)	NS(A)	NS(A)	NS(A)	700	600	1640	1440						
L4	6"	NS	NS	Acid	Acid	NS(A)	NS(A)	NS(A)	NS(A)					3390	3140
	2'	NS	NS	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)					NS	NS
	6'	NS	NS	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)					NS	NS
L5	6"	NS	NS	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)					2900	2680
	2'	NS	NS	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)					NS	NS
	6'	NS	NS	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)	NS(A)					NS	NS

NOTE: For those samples designated "Acid", only a highly (hydrochloric acid- or nitric acid-) acidified sample was submitted for analysis. Since the total dissolved solids determined for these samples would have indicated a TDS concentration not representative of the leachate as-sampled, the total dissolved solids were not determined for these samples, and TDS values for these samples are therefore unavailable.

For some of the acidified samples, as on approximation to the actual TDS concentration, the sum of the concentration of the major constituents has been calculated, and that value, if available, is inserted parenthetically.

TOTAL DISSOLVED SOLIDS (mg/l)

(L IMPOUNDMENTS)

		360 Day		390 Day		450 Day		480 Day		570 Day		600 Day	
Site	Zone	105°C	590°C	105°C	590°C	105°C	590°C	105°C	590°C	105°C	590°C	105°C	590°C
L1	6"	3110	2930									2080 (V(M)) (1680) (2480)	1900 (V(M)) (1530) (2270)
	2'	2470	2230									1330	1200
	6'	NS(A)	NS(A)									NS	NS
L2	6"									3580	3260		
	2'									NS	NS		
	6'									390	330		
L3	6"	2160	1960			NS	NS						
	2'	1730	1620			NS	NS						
	6'	1310	1210			1230	1100						
L4	6"			NS	NS			3680	3330				
	2'			NS	NS			NS	NS				
	6'			NS	NS			NS	NS				
L5	6"			NS	NS			2950	2720				
	2'			NS	NS			NS	NS				
	6'			NS	NS			NS	NS				

TOTAL DISSOLVED SOLIDS (mg/l)

(REFERENCE SAMPLES)

Sample	2/77 105°C	2/77 590°C	8/77 105°C	8/77 590°C	10/77 105°C	10/77 590°C	12/78 105°C	12/78 590°C
Rainwater			315(US)	280(US)			47(US)	34(US)
Water from government test well	88	83			610	500		
Water from #5 deep well	820	710			690	620		

NOTE: The values for total dissolved solids for the rainwater samples taken on 8/77 and 12/78 are actually values for total (dissolved plus undissolved) solids, since the values were determined on representative aliquots of the samples as-received. For the first (8/77) rainwater sample the reported value at 105°C consists of approximately 100 mg/l total undissolved solids and approximately 210 mg/l total dissolved solids. For the second (12/78) sample, based on the appearance of the sample, the reported value consists of negligible total undissolved solids, and the reported value is essentially the value for total dissolved solids.

VANADIUM (mg/l)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day
S1	1 (BOR)	<1	<1	NS(A)	NRS(F)		<1(HS)	<0.5	0.2
	2 (OF)	<1	<1	NS(A)	NRS(F)		<1(HS)	<0.5	NS(A)
	3 (BIR)	<1	NS	NS(A)	NRS(R)		<1(HS)	<0.5	<0.1
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		<1	<0.5	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	<1		<1(HS)	<0.5	0.2
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		<1	<0.5	0.2
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		<1	<0.5	
	2 (OF)	NS	NS(A)	NS(A)	<1		<1(HS)	<0.5	
	3 (BIR)	NS	NS(A)	NS(A)	NS		<1	<0.5	
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		<1	<0.5	
	2 (OF)	NS	NS(A)	NS(A)	<1		<1(HS)	<0.5	
	3 (BIR)	NS	NS(A)	NS(A)	<1		<1	<0.5	
S5	1 (BOR)	NS(A)	NS(A)	<0.5	<0.1				
	2 (OF)	NS(A)	NS(A)	<0.5	NS(A)				
	3 (BIR)	<1	NS(A)	<0.5	0.2				
S6	1 (BOR)	NS(A)	NS(A)	<0.5	<0.5				
	2 (OF)	NS(A)	NS(A)	<0.5	NS(A)				
	3 (BIR)	NS(A)	NS(A)	<0.5	<0.1				
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)			
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)			
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	0.1	0.3			
	3 (BIR)	--	--	NS(A)	0.2	0.2			
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)			
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)			
	3 (BIR)	--	--	NS(A)	0.3	NS(A)			

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VANADIUM (mg/1)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	360 Day
L1	6"	NS	<1	<1	<1	<1	<0.5	0.3
	2'	NS	<1	<1	<1	NS	NS (A)	0.1
	6'	NS	<1	<1	ISP	ISP	NS (A)	NS (A)
L2	6"	<1	<1	<1	NS	<1	<0.5	
	2'	<1(HS)	NS (A)	ISP	NS	<1	NS (A)	
	6'	<1(V)	<1	<1	NS	<1	NS (A)	
L3	6"	NS (A)	NS (A)	<0.5	0.4			
	2'	NS (A)	NS (A)	<0.5	NS (A)			
	6'	NS (A)	NS (A)	<0.5	0.2			
L4	6"	NS	<0.5	NS (A)	NS (A)			
	2'	NS	NS (A)	NS (A)	NS (A)			
	6'	NS	NS (A)	NS (A)	NS (A)			
L5	6"	NS	NS (A)	NS (A)	NS (A)			
	2'	NS	NS (A)	NS (A)	NS (A)			
	6'	NS	NS (A)	NS (A)	NS (A)			

VANADIUM (mg/1)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77
Rainwater		<0.5(US(D))	
Water from government test well	<1		<0.5
Water from #5 deep well	<1		<0.5

ZINC (mg/1)

(S IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	120 Day	180 Day	270 Day	360 Day	390 Day	450 Day	480 Day	630 Day	660 Day
S1	1 (BOR)	0.025	0.009	NS(A)	NRS(F)		0.13(HS)	0.08	0.06				NS	
	2 (OF)	0.094	0.017	NS(A)	NRS(F)		<0.01(HS)	0.06	NS(A)				0.036	
	3 (BIR)	0.025	NS	NS(A)	NRS(R)		0.02(HS)	0.07	0.08				NS	
S2	1 (BOR)	NS	NS(A)	NS(A)	NS(A)		0.025	0.18	NS(A)				0.036	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.030		0.17(HS)	0.04	0.09				0.032	0.036
	3 (BIR)	NS	NS(A)	NS(A)	NS(A)		<0.01	0.05	0.08				NS	NS(A)
S3	1 (BOR)	NS	NS(A)	NS(A)	NS		0.023	0.04					NS	NS(A)
	2 (OF)	NS	NS(A)	NS(A)	0.017		0.027(HS)	0.05					NS	NS(A)
	3 (BIR)	NS	NS(A)	NS(A)	NS		0.069	0.03					NS	NS(A)
S4	1 (BOR)	NS	NS(A)	NS(A)	NS		0.054	0.05					NS	0.077
	2 (OF)	NS	NS(A)	NS(A)	0.075		0.019(HS)	0.05					0.032	0.054
	3 (BIR)	NS	NS(A)	NS(A)	0.023		0.023	0.13					NS	NS(A)
S5	1 (BOR)	NS(A)	NS(A)	0.16	0.06					NS	0.010			
	2 (OF)	NS(A)	NS(A)	0.06	NS(A)					NS	NS(A)			
	3 (BIR)	0.019	NS(A)	0.15	0.08					NS	NS(A)			
S6	1 (BOR)	NS(A)	NS(A)	0.05	0.06					NS	0.061			
	2 (OF)	NS(A)	NS(A)	0.06	NS(A)					0.378	NS(A)			
	3 (BIR)	NS(A)	NS(A)	0.06	0.07					NS	NS(A)			
S7	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				0.677		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				0.072		NS(A)		
	3 (BIR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
S8	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NRS(R)		
	2 (OF)	--	--	NS(A)	0.07	0.20				0.046		0.118		
	3 (BIR)	--	--	NS(A)	0.07	0.11				NS		NS(A)		
S9	1 (BOR)	--	--	NS(A)	NS(A)	NS(A)				NS		NS(A)		
	2 (OF)	--	--	NS(A)	NS(A)	NS(A)				1.06		0.024		
	3 (BIR)	--	--	NS(A)	0.07	NS(A)				NS		0.045		

ZINC (mg/1)

(L IMPOUNDMENTS)

Site	Zone	0 Day	30 Day	60 Day	90 Day	180 Day	270 Day	300 Day	360 Day	390 Day	450 Day	480 Day	570 Day	600 Day
L1	6"	NS	0.039	0.019	0.019	0.010	0.08		0.10					0.056 (V(M))
	2'	NS	0.132	0.128	0.173	NS	NS(A)		0.20					0.359
	6'	NS	0.208	0.115	ISP	ISP	NS(A)		NS(A)					NS
L2	6"	0.072	0.221	0.245	NS	0.127	0.10						0.045	
	2'	0.153(HS)	NS(A)	ISP	NS	0.162	NS(A)						NS	
	6'	0.051(V)	0.022	0.019	NS	0.135	NS(A)						0.039	
L3	6"	NS(A)	NS(A)	0.26	0.19				0.175		NS			
	2'	NS(A)	NS(A)	0.38	NS(A)				0.142		NS			
	6'	NS(A)	NS(A)	0.10	0.17				0.125		0.131			
L4	6"	NS	0.40	NS(A)	NS(A)			0.086		NS		0.190		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
L5	6"	NS	NS(A)	NS(A)	NS(A)			0.060		NS		0.059		
	2'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		
	6'	NS	NS(A)	NS(A)	NS(A)			NS		NS		NS		

ZINC (mg/1)

(REFERENCE SAMPLES)

Sample	2/77	8/77	10/77	12/78
Rainwater		0.09(US(D))		0.007(US)
Water from government test well	0.008		0.01	
Water from #5 deep well	0.008		0.06	

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Appendix C

Field Tests

Discussion and Summary
Phase I - Carbide Lime Tests

October 27 to December 21, 1977

Introduction

The scrubber operation section details the assistance provided by C-E in continuous monitoring of liquid and solid phase chemistry to insure attainment of desired experimental conditions as well as to maintain scale-free operation of the AQCS.

The waste disposal section provides background on preparation of impoundment mixtures and preliminary field composition determinations.

Phase I - Scrubber Operation
C-E Assessment of Steady-State

Scrubber Operation - Phase I (10/27-11/15/77)

Shakedown Scrubber B was on line October 27 with the boiler at half-load (35 MW) burning special 1.5 to 2% S coal. Sampling began on October 28 (See Supplement Table).In an effort to build up solids more rapidly, the boiler was taken to full load (70 MW) and both scrubbers operated for 5 hours.

Single scrubber operation (B Scrubber) resumed October 29. Even though the program called for 10%, the system was operating during this period at an average of 6-7% solids (9.2 LG&E reading). Ease of operation and the lower sulfur fuel were indicated causes. The carbide lime currently being used contained significant magnesium resulting in a slurry magnesium concentration (Mg) considerably higher than observed in previous Paddys Run operation (∿200 ppm).

During the next few days, the solids concentration remained around 7% (9% LG&E) which corresponded to 1974 operating conditions and it was agreed to revise the current test program accordingly. The Mg concentration continued to rise to around 1000 ppm by November 3. The solids % oxidation of sulfite dropped from 22% to around 13% for about one week (until November 8).

The regular 2.5% sulfur coal was resumed on November 3 and inlet SO_2 steadied at an average of 1900 ppm. The magnesium content continued to rise to about 1200 ppm, whereupon blowdown was initiated. Coupled with a change in the source of make-up water for the carbide lime slurry, the blowdown was expected to reduce Mg levels to 1974 operation levels.

By November 15, the Mg level was in the 200-300 ppm range and blowdown was stopped. On November 18, liquid phase concentrations seemed to be stable and solid phase concentrations leveling off with Mg at 230 ppm in the liquid and about 0.1% in the solid phase. The solids % oxidation of sulfite leveled off around 8%; well below saturation conditions.

It was agreed by all parties that steady-state was being approached and Test 1 could begin soon.

Test 1 - Carbide Lime Base-Case Conditions (11/16-12/2/77)

Steady-state conditions appeared to be holding with approximate spray water concentrations of Ca^{++} 600-700 ppm, Mg^{++} 100 ppm, $SO_4^{=}$ 900-1200 ppm and $SO_3^{=}$ 80 ppm. The Mg^{++} concentration in the incoming additive dropped from nearly 1.2% to <0.1% and blowdown of the thickener overflow, designed to reduce spray water Mg content, was thus stopped.

Settling rates were steady within 2 days of start of this test and bleed-off of slurry for the waste disposal portion was started (see later description). Operational monitoring by C-E was suspended over Thanksgiving (November 23-29) however, except for a slight increase in chloride (570 to 790 ppm) the system held at steady-state.

During a two-hour shutdown inspection of the scrubber, a 1/16 inch scale buildup was noted in some areas. It is not known whether this buildup occurred during the base-case operation or during the one or two day startup period.

Tests 2 & 3 - Variation in Slurry Flow Rate (12/3/76)

These two tests at 4000 and 8000 gpm were run for four-hour periods while slurry samples were taken by Radian. Normal slurry flow rate of 6000 gpm was maintained for two hours between tests.

Tests 4 & 5 - Variation in Slurry pH (12/6/77)

These two tests, at pH 6.5 and 9, were run for four-hour periods while slurry samples were taken by Radian. Normal slurry pH of 8 was maintained for two hours between tests. At pH 6.5, SO_2 removal was 72% and at pH 9, 77.9% SO_2 removal occurred.

Test 6 - Effect of Reduction in Slurry Solids (12/7/76 to 12/15/76)

The system solids were reduced to 3.5% within two days. A slight change in oxidation was noted (from 9 to 13%). Mg# was at 100 ppm, Ca#-850 ppm, $Cl^{=}$-800 ppm, $SO_4^{=}$ 1200 ppm and $SO_3^{=}$ 60 ppm.

Test 1 - (Repeat Base Case) - 12/16-21/76

Based on the observation that subsaturated operation had been demonstrated at low solids (3%), EPA accepted the Radian recommendation that Tests 7 and 8 (the effect of higher air, excess air and higher Mg concentration) be omitted. The Particle Balance test (No. 9) was scheduled, however discrepency* in the results using the Radian procedure for sulfite analysis caused a re-running of Tests 1, 2 and 3 in an attempt to obtain required data.

Liquid phase concentrations of all species lined out at levels similar to those obtained in the original Test 1, however sulfate levels were lower (600 ppm vs. 1200 ppm).

*The Radian procedure for $SO_3^{=}$ determination (as well as the C-E procedure) involves addition of the sample to a known volume of iodine and back titration of the excess iodine with standard thiosulfate. However, Radian buffers the solution at pH 6 while C-E using a modified ASTM standard water analysis procedure which requires acidification (~pH 2) of the solution prior to titration. The results using the Radian procedure are time dependent after addition of buffer, whereas the C-E procedure provides the same result regardless of time after sample preparation.

Tests 2 & 3 (Repeats) - 12/22/76 - Variation in Slurry Flow Rate

These tests were repeated (4 hours each) during the last day of testing prior to a Christmas break.

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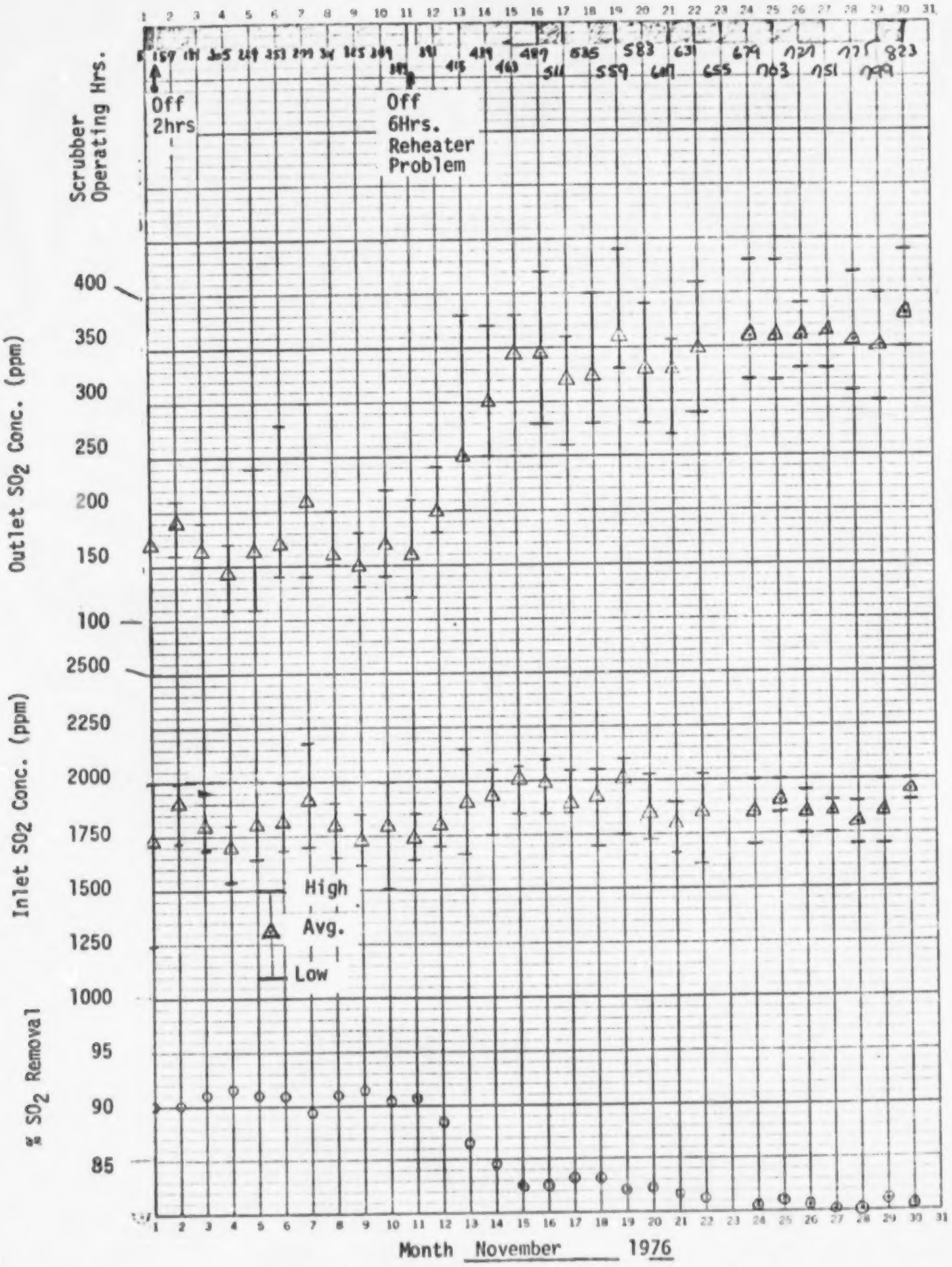

Scrubber Operating Hrs and SO_2 Concentrations

Figure C-1a

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3/8"
BOTTOM OF IMAGE AREA OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS

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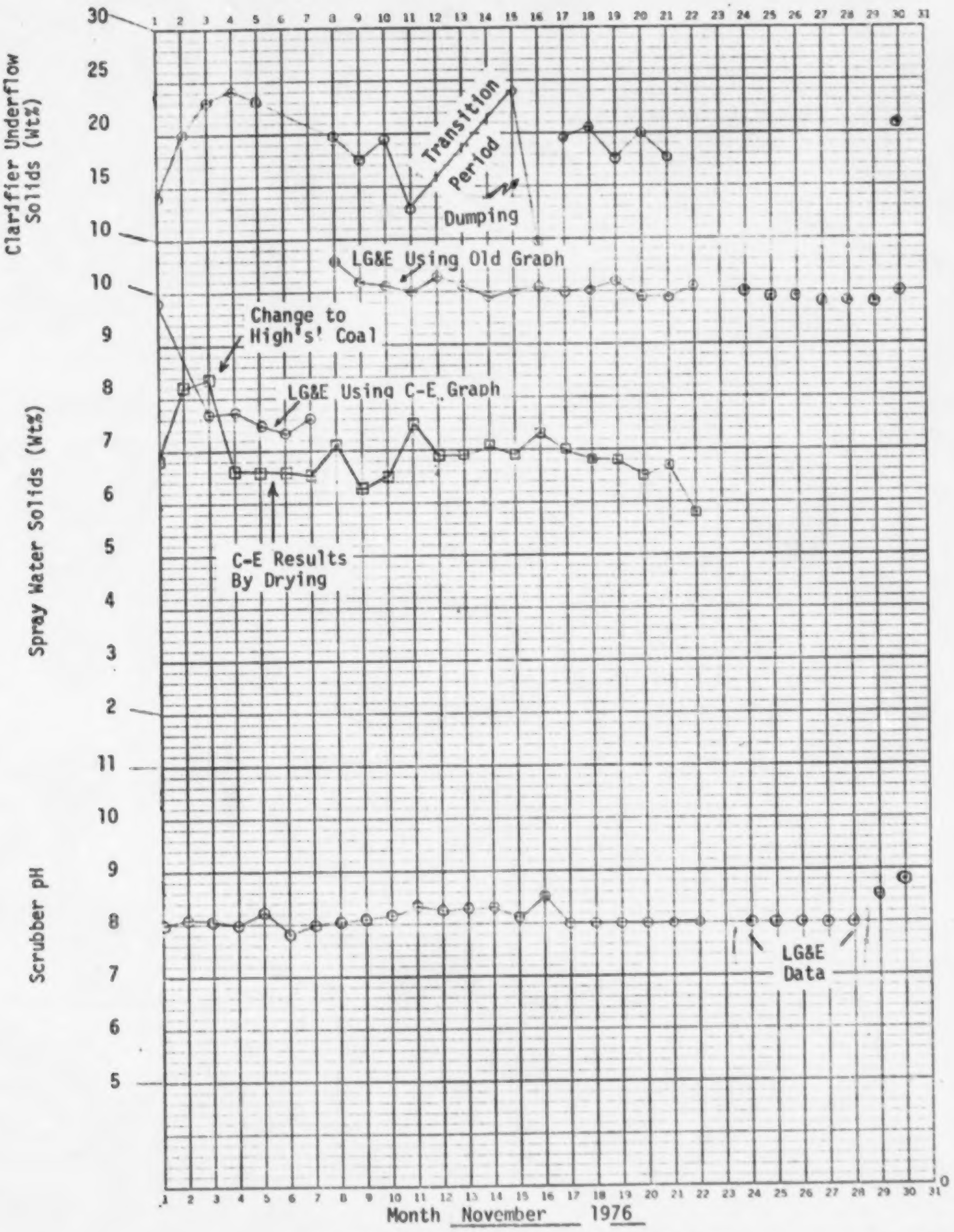

Spray Water Slurry and Clarifier Underflow

Figure C-1b

BEGIN LAST LINE OF TEXT
BOTTOM OF IMAGE AREA OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
3/8"

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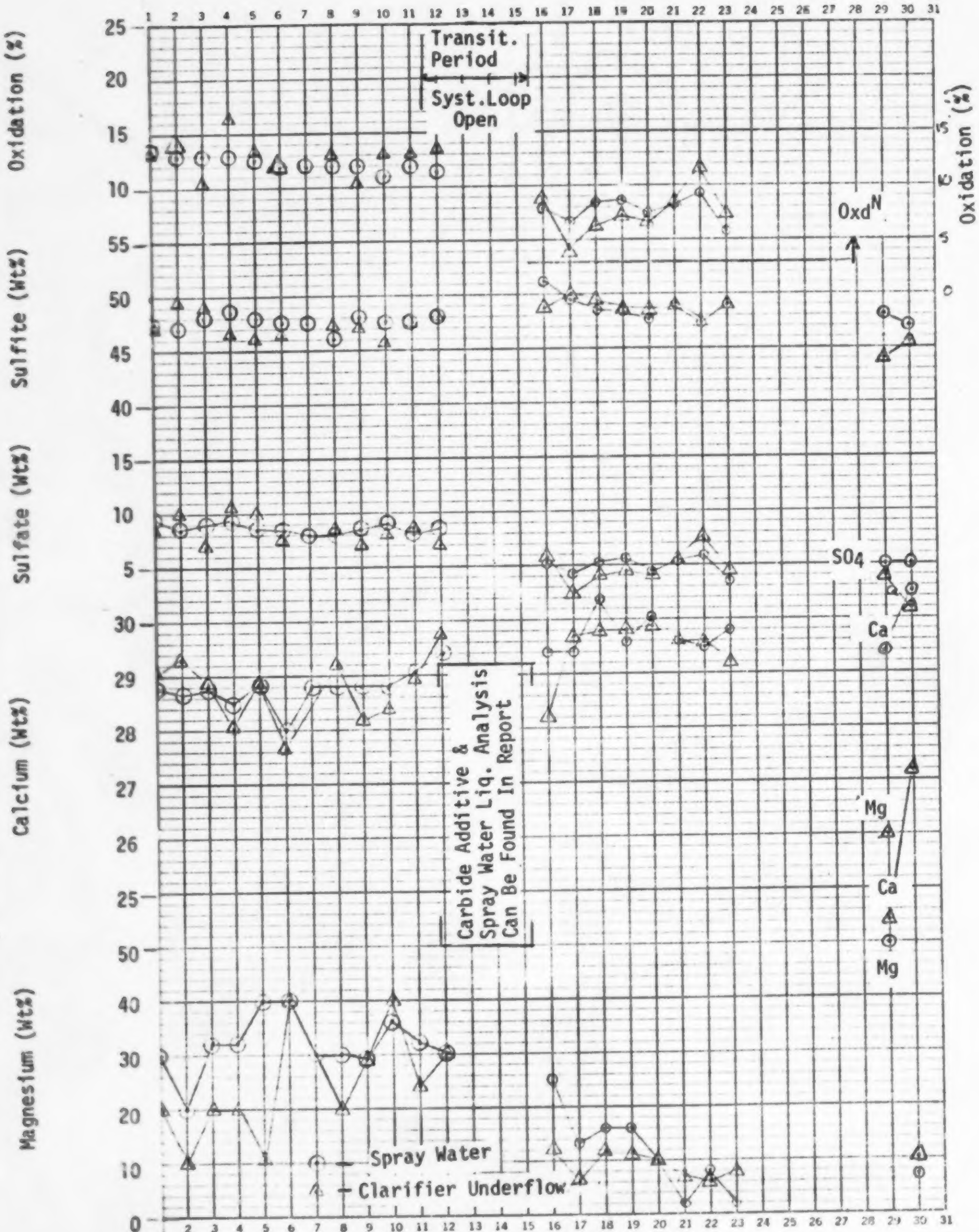

Month November 1976

Scrubber Slurry - Solids

Figure C-1c

BEGIN LAST LINE OF TEXT
BOTTOM OF IMAGE AREA: OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
3/8"

PAGE NUMBER
EPA Form 2350-4 (4-80)
(PREVIOUSLY CIN: EPA FORM 287)
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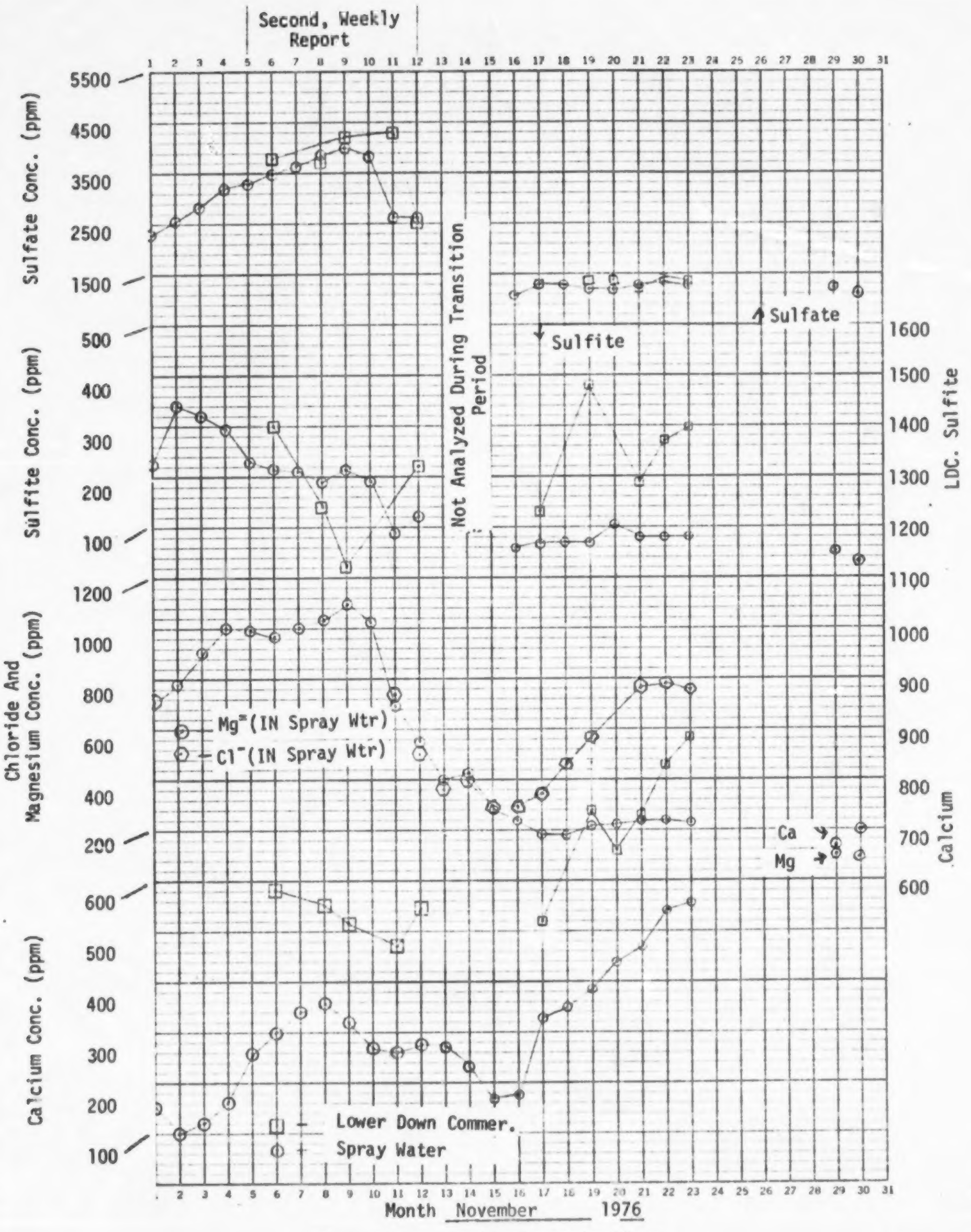

Spray Water Liquids Concentrations

Figure C-1d

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3/8"

BOTTOM OF IMAGE AREA: OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS

PAGE NUMBER

EPA Form 2350-4 (4-80)
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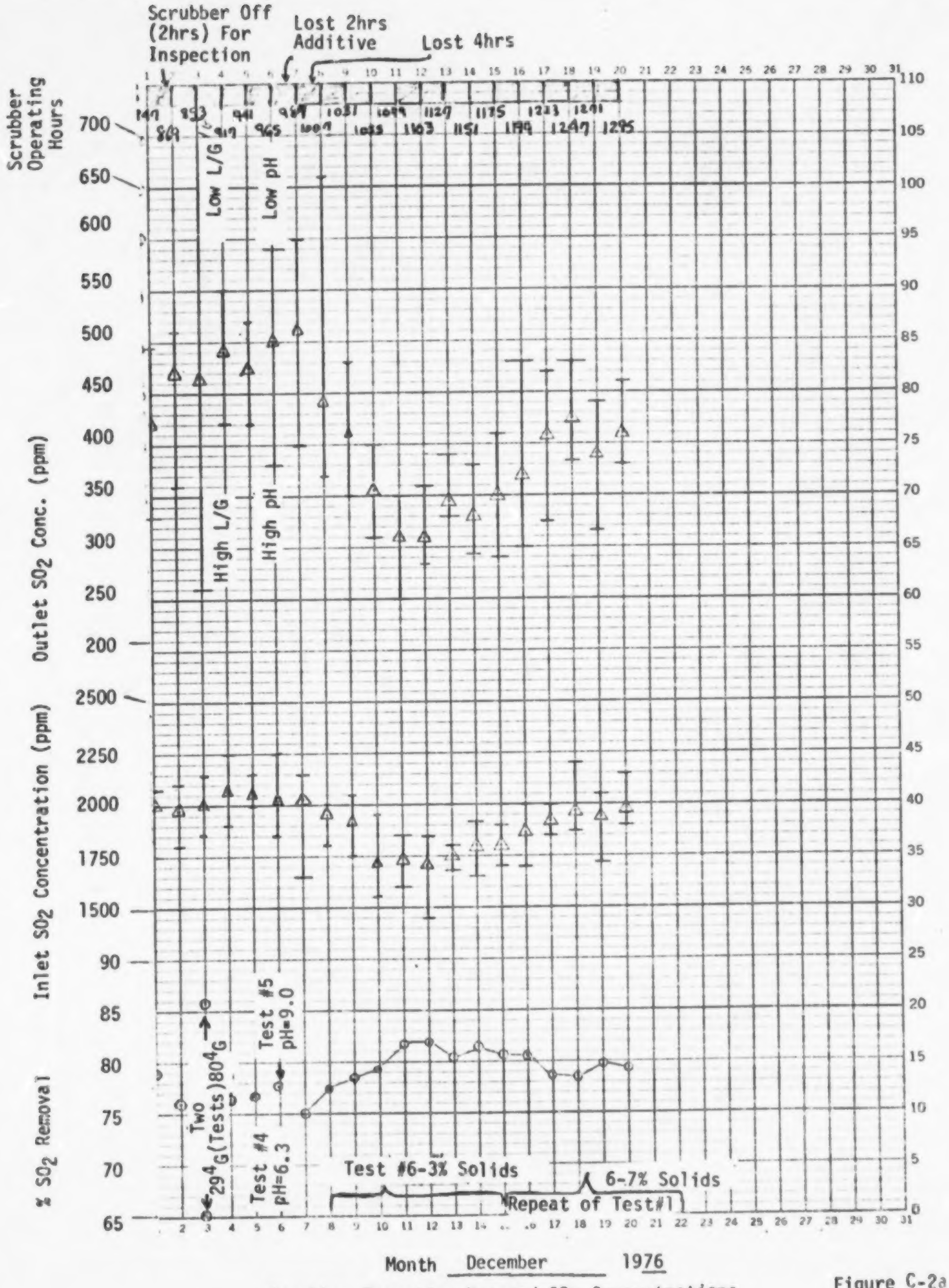

Scrubber Operating Hrs and SO_2 Concentrations

Figure C-2a

BEGIN LAST LINE OF TEXT
BOTTOM OF IMAGE AREA OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
3/8"

PAGE NUMBER
EPA Form 2350-4 (4-80)
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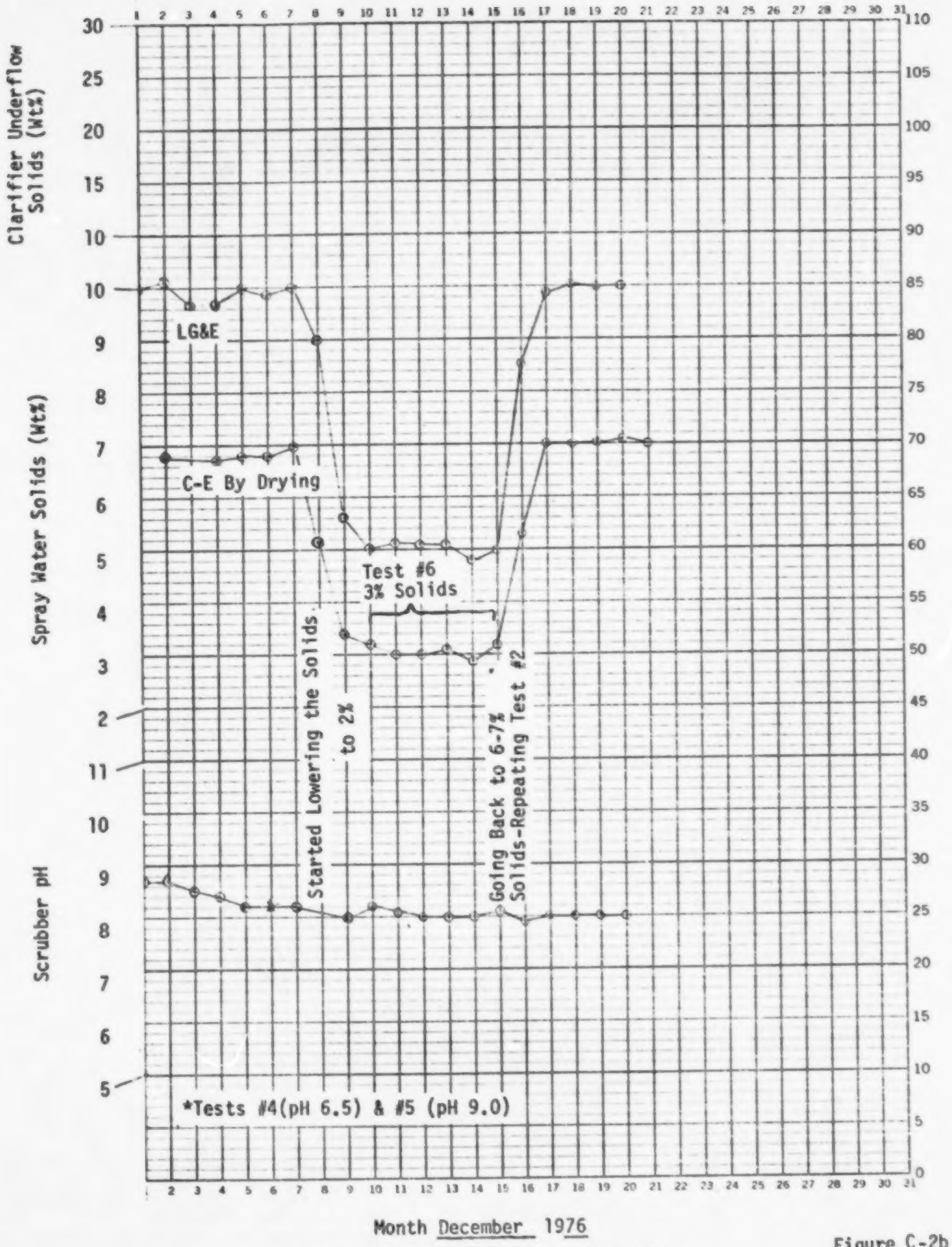

Spray Slurry and Clarifier Underflow

Figure C-2b

EPA Form 2350-4 (4-80)
(PREVIOUSLY CIN. EPA FORM 287)
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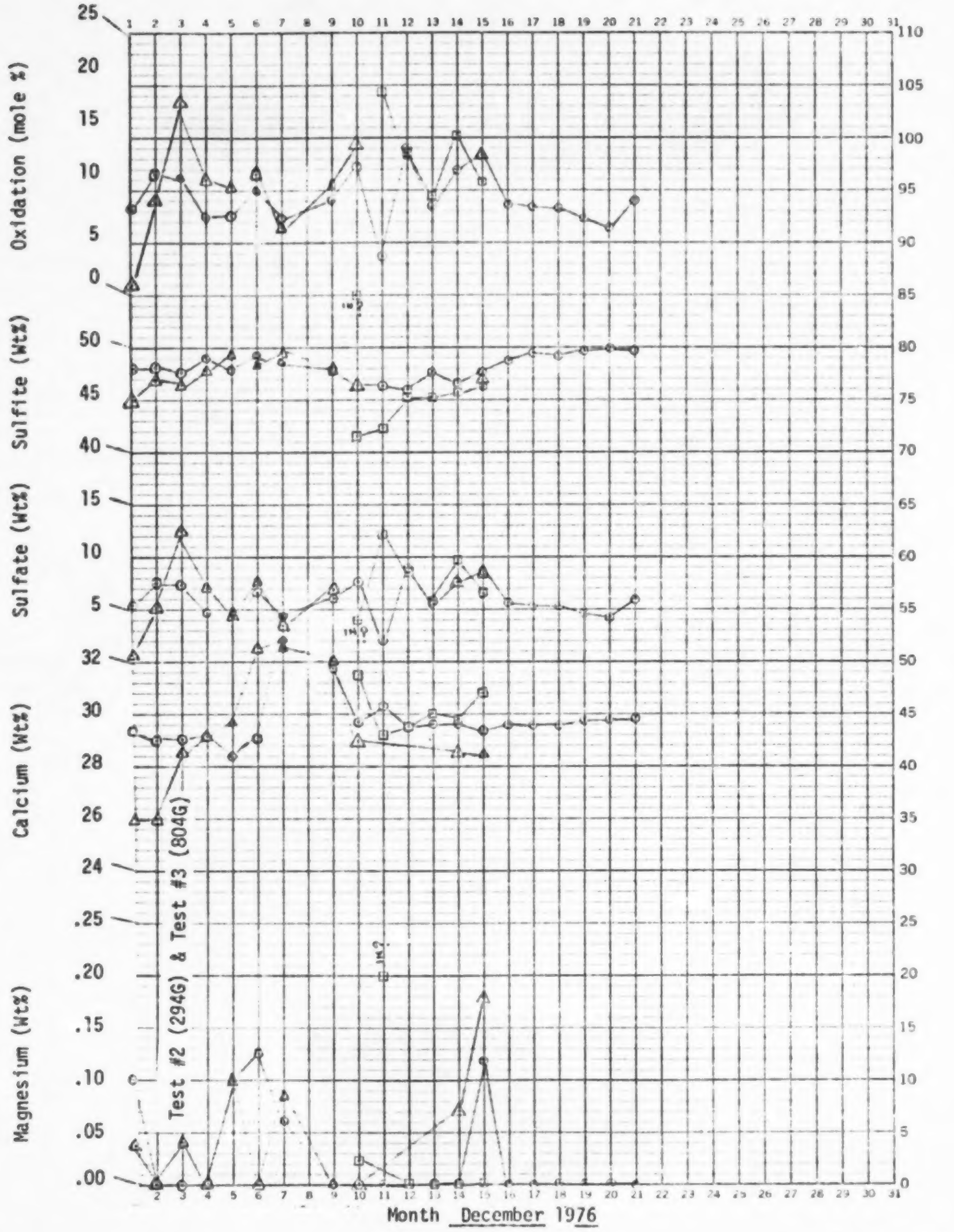

Scrubber Slurry - Solids

Figure C-2c

BEGIN LAST LINE OF TEXT
BOTTOM OF IMAGE AREA: OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
3/8"

PAGE NUMBER
EPA Form 2350-4 (4-80)
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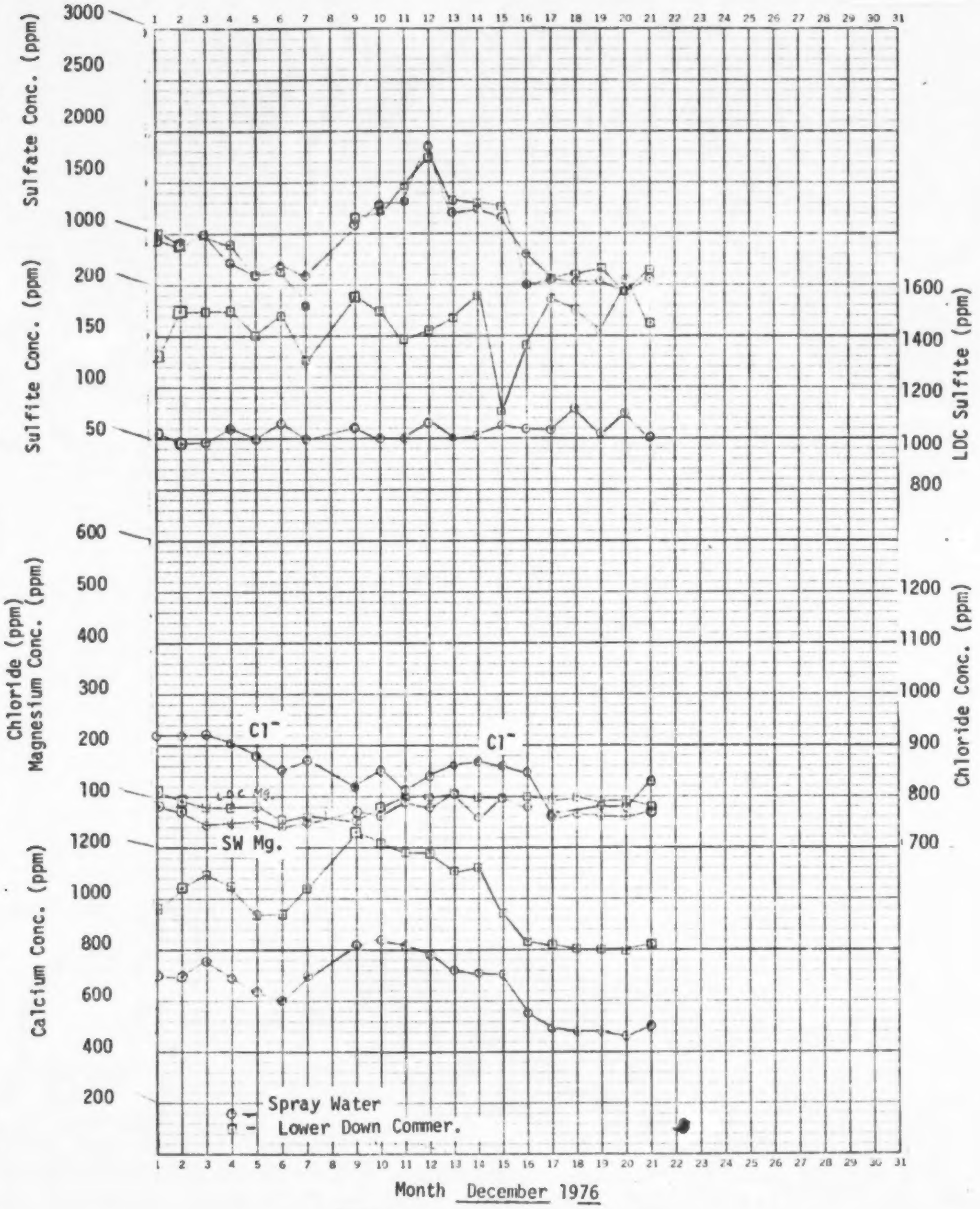

Spray Water Liquid Concentrations

Figure C-2d

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BOTTOM OF IMAGE AREA, OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS

PAGE NUMBER
EPA Form 2350-4 (4-80)
(PREVIOUSLY CIN. EPA FORM 287)
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TABLE C-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^-	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
10/28/76	1420	1	SW	6.7	-	8.3	524	303	56	2072	-	28.4	0.3	44.2	15.2	22.3
10/29/76	1130	5	TU	10.3	-	-	-	-	-	-	-	28.8	0.04	44.6	16.1	22.0
	1300	2	SW	9.1	-	8.2	320	310	99	1610	-	28.8	0.3	44.0	18.2	25.6
10/30/76	1200	3	SW	7.0	115	8.2	164	470	154	1684	-	29.1	0.08	44.4	11.6	17.9
10/31/76	0825	4	SW	7.1	-	8.1	167	559	162	2001	-	28.9	0.11	47.5	11.8	17.2
11/1/76	0920	6	SW	6.8	122	8.2	207	624	166	2307	-	28.6	0.4	47.0	10.5	15.7
	1700	7	SW	6.4	115	8.1	132	693	232	2261	-	28.9	0.3	46.2	9.8	15.0
	1700	8	TU	-	-	-	-	-	-	-	-	29.0	0.2	47.4	8.6	13.1
	2300	9	SW	7.0	115	8.1	122	722	281	2329	-	29.0	0.2	47.5	7.9	12.2
11/2/76	1115	10	SW	7.6	120	8.2	107	782	307	2460	-	28.8	0.3	48.4	8.5	12.8
	1700	11	SW	7.8	118	8.2	98	720	341	2510	-	28.8	0.3	47.4	8.5	13.0
	1700	12	TU	-	-	-	-	-	-	-	-	29.3	0.1	49.1	10.2	14.8
	2300	13	SW	9.4	118	8.1	99	868	359.8	2610	-	28.6	0.4	48.0	9.3	13.9
11/3/76	0845	14	SW	7.0	120	8.1	118	887	324	2750	-	28.9	0.4	48.5	8.9	13.3
	1700	15	SW	7.7	118	8.2	122	906	311.8	2919	-	28.7	0.2	48.4	9.3	13.8
	1700	16	TU	-	-	-	-	-	-	-	-	29.0	0.2	48.8	7.0	10.7
	2300	17	SW	7.8	118	8.1	124	914	316.4	2908	-	28.5	0.4	48.3	8.0	12.1
11/4/76	0840	18	SW	7.0	118	8.2	132	989	328	3130	-	28.6	0.4	48.4	9.6	14.2
	1600	19	SW	6.7	117	8.2	159	995	291.8	3327	-	28.6	0.1	48.4	11.9	17.0
	1600	20	TU	-	-	-	-	-	-	-	-	28.0	0.2	46.7	11.7	17.3
	2100	21	SW	6.7	116	8.2	182	979	252	3309	-	29.5	0.5	48.2	7.1	10.9
11/5/76	0840	22	SW	7.1	118	8.2	186	1018	263	3110	-	29.5	0.5	48.4	8.2	12.4
	1700	23	SW	6.6	116	8.3	250	999	218	3248	-	28.9	0.3	48.0	8.9	13.4
	1700	24	TU	-	-	-	-	-	-	-	-	28.8	0.1	46.6	8.4	13.1
	2200	25	SW	6.2	115	8.15	261	963	203	3430	-	28.1	0.4	47.6	8.1	12.4
11/6/76	0900	26	SW	6.6	117	7.8	308	954	213	3494	-	28.1	0.4	47.5	8.2	12.6
	0900	27	TU	-	-	-	-	-	-	-	-	27.4	0.4	46.5	7.8	12.3
	0900	28	LDC	-	115	5.4	580	1007	1397	3767	-	-	-	-	-	11.8

Key
SW = Spray Water
TU = Thickener Underflow
LDC = Lower Downcomer

EPA Form 2350-4 (4-80)
(PREVIOUSLY CIN. EPA FORM 337)
U.S. GOVERNMENT PRINTING OFFICE 1980-680-639
TYPING GUIDE SHEET

TABLE C-1
CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	$Ca^{\ddagger}$	$Mg^{\ddagger}$	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	$Ca^{\ddagger}$	$Mg^{\ddagger}$	$SO_3^{=}$	$SO_4^{=}$	Oxidation
11/ 7/76	1145	29	SW	6.5	118	8.0	345	995	209	3660	-	28.8	0.3	47.2	7.6	11.8
11/ 8/76	0920	30	SW	7.3	118	8.3	352	1053	211	3770	-	28.8	0.2	47.1	8.5	13.1
	0930	31	LDC	-	-	5.3	572	1003	1240	3660	-	-	-	-	-	13.7
	1600	32	SW	7.3	117	8.1	354	1033	189	3730	-	28.5	.4	47.1	9.0	13.7
	2200	33	SW	-	117	8.7	368	1014	185	3990	990	29.1	0.3	47.4	6.8	10.6
	0920	34	SW-E	-	118	7.7	556	1196	6.0	5108	-	-	-	-	-	13.3
	2200	35	TU	-	-	-	-	-	-	-	-	29.2	0.2	47.3	8.7	13.3
11/ 9/76	0845	36	SW (solids)	6.4	-	-	-	-	-	-	-	-	-	-	-	-
	1530	37	SW	6.1	117	8.1	368	1092	217	4204	-	29.1	.3	46.0	9.0	14.0
	1530	38	LDC	-	-	-	612	1124	1428	4424	-	-	-	-	-	-
	1530	39	TU	-	-	-	-	-	-	-	-	28.3	.3	47.0	6.9	10.9
	1530	40	SW-E	-	-	-	566	1086	0	4760	-	-	-	-	-	-
	2230	41	SW	-	117	8.2	272	1128	217	3980	-	29.0	0.2	47.4	5.8	9.3
	2230	42	LDC	-	118	5.3	432	960	658	4000	1060	-	-	-	-	-
11/10/76	0915	43	SW	6.5	118	8.1	272	1235	253	4270	-	28.6	0.4	47.5	5.7	9.1
	1500	44	SW	6.3	118	8.2	284	1245	253	4309	-	29.2	.2	47.0	5.1	8.3
	1500	45	TU	6.7	117	8.2	-	-	-	-	-	28.4	.4	45.4	8.2	13.1
	2130	46	SW	-	-	-	248	981	169	3353	-	28.5	0.5	47.3	9.8	14.7
	0910	47	SW-E	-	-	-	532	1660	18	6630	-	-	-	-	-	-
11/11/76	0900	48	SW	6.6	117	8.3	290	860	-	3500	745	28.7	0.3	47.3	10.0	15.0
	0900	49	LDC	-	-	5.4	470	770	-	4400	-	-	-	-	-	-
	0900	50	SW-E	-	-	-	548	959	1	4383	-	-	-	-	-	-
	1600	51	SW	7.1	115	8.3	283	815	115	2980	-	28.9	.24	47.6	7.1	11.3
	1600	52	TU	-	-	-	-	-	-	-	-	28.9	.24	47.6	8.7	13.2
	2200	53	SW	8.7	110	8.4	253	634	64	1256	-	29.5	0.4	48.3	6.7	10.4
11/12/76	0830	54	SW	6.5	109	8.2	316	588	130	3410	497	29.4	0.3	48.2	9.6	14.2
	0830	55	LDC	-	116	5.4	544	582	1320	2390	-	-	-	-	-	-
	1600	56	SW	7.4	116	8.3	269	547	81	2123	-	29.5	.3	47.3	7.3	11.4
	1600	57	TU	-	-	-	-	-	-	-	-	29.7	.3	48.0	7.0	10.8
	2200	58	SW	9.0	112	8.3	257	518	120	1918	-	-	-	-	-	-

SW-E = Equilibrium Concentration Study

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BOTTOM OF IMAGE AREA OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
EPA Form 2350-4 (4-80)
(PREVIOUSLY CIN. EPA FORM 287)
U.S. GOVERNMENT PRINTING OFFICE 1980-660-635
TYPING GUIDE SHEET

TABLE C-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
11/13/76	1000	59	SW	6.9	-	8.3	237	401	-	-	367	-	-	-	-	-
	1000	60	CA	-	-	12.4	-	-	-	-	219	47.6	0.72	-	-	-
11/14/76	0930	61	SW	7.1	117	8.3	233	431	-	-	405	-	-	-	-	-
	0930	62	CA	-	-	-	-	-	-	-	263	47.4	0.76	-	-	-
	0830	63	SW	7.1	-	8.1	178	310	-	-	339	-	-	-	-	-
	0830	64	CA	-	-	-	-	-	-	-	254	46.9	1.00	-	-	-
	2100	65	SW	6.7	-	-	163	257	-	-	263	-	-	-	-	-
	2100	66	CA	-	-	-	-	-	-	-	197	47.6	0.6	-	-	-
11/16/76	0900	67	SW	7.2	-	8.5	156	240	-	-	250	-	-	-	-	-
	0900	68	CA	-	-	-	-	-	-	-	340	48.5	0.1	-	-	-
	1430	69	CA	-	-	-	-	-	-	-	-	44.9	0.2	-	-	-
	1700	70	SW	7.2	-	-	-	-	-	-	-	29.4	0.25	51.3	5.3	7.9
	1700	71	TU	-	-	-	-	-	-	-	-	28.2	0.12	48.9	5.7	8.9
	2100	72	SW	7.4	-	-	206	239	77.6	1080	283	-	-	-	-	-
	2100	73	CA	-	-	-	-	-	-	-	-	48.1	0.1	-	-	-
11/17/76	0945	74	SW	6.9	119	8.6	305	217	80	1185	374	29.7	0.1	50.2	4.1	6.4
	1000	75	LDC	-	121	5.3	520.	290	135	1300	-	-	-	-	-	-
	1700	76	SW	7.3	117	8.3	318	112	60	1238	329	29.5	0.1	49.2	4.4	6.9
	1700	77	TU	-	-	-	-	-	-	-	-	29.7	0.06	50.0	2.6	4.2
	2200	78	SW	7.0	117	8.3	364	236	71	1389	-	29.1	0.2	49.2	4.4	6.9
	2200	79	CA	-	-	-	-	-	-	-	-	48.5	0.05	-	-	-
11/18/76	0915	80	SW	6.8	120	8.6	382	231	71	1350	473	29.7	0.2	49.0	5.2	8.1
	1700	81	SW	6.8	117	8.4	330	147	78	1212	-	31.14	0.12	48.3	5.4	8.5
	1700	82	TU	-	-	-	-	-	-	-	-	29.78	0.12	49.5	4.0	6.3
	2200	83	SW	6.7	116	8.3	346	234	72.7	994	-	29.6	0.1	48.8	5.0	7.9

CA = Carbide Additive Slurry

TABLE C-1
CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	$Ca^{\ddagger}$	$Mg^{\ddagger}$	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	$Ca^{\ddagger}$	$Mg^{\ddagger}$	$SO_3^{=}$	$SO_4^{=}$	Oxidation
11/19/76	0845	84	SW	6.9	120	8.3	409	235	86	1323	572	29.5	0.2	48.9	5.2	8.1
	0900	85	LDC	-	124	5.2	729	267	1477	1324	-	-	-	-	-	-
	1700	86	SW	6.9	-	-	388	240	76	1201	-	29.7	.2	48.4	6.5	10.1
	1700	87	TU	-	-	-	-	-	-	-	-	29.8	.1	48.5	4.5	7.2
	2130	88	SW	6.7	-	-	364	230	63	1149	-	-	-	-	-	-
11/20/76	0830	89	SW	6.4	117	8.1	440	238	107	1239	-	30.1	0.1	47.7	4.5	7.3
	0830	90	LDC	-	120	4.9	664	228	881	1372	-	-	-	-	-	-
	0830	91	TU	-	-	-	-	-	-	-	-	29.9	0.1	48.6	4.3	6.9
11/21/76	0930	92	TU	-	-	8.8	-	-	-	-	-	29.6	0.07	48.9	5.4	8.4
	0945	93	SW	6.7	116	8.6	468	240	81	1298	770	29.6	0.02	49.2	5.2	8.1
	1030	94	LDC	-	121	5.4	736	258	1293	1217	-	-	-	-	-	-
11/22/76	0845	95	SW	6.5	120	8.3	540	240	82	1318	795	29.5	0.08	48.4	5.8	9.1
	0845	96	LDC	-	121	5.3	832	262	1374	1376	-	-	-	-	-	-
	0845	97	TU	-	-	-	-	-	-	-	-	29.6	0.05	48.7	7.7	11.6
11/23/76	0900	98	SW	5.8	115	8.5	553	230	87	1272	770	29.8	0.02	49.0	3.53	5.7
	0900	99	LDC	-	120	5.2	866	243	1397	1342	-	-	-	-	-	-
	0900	100	TU	-	-	-	-	-	-	-	-	29.2	0.08	49.0	4.70	7.4
	0900	101	SW-E	-	118	7.2	764	226	20	1907	810	-	-	-	-	-
11/29/76	1700	102	SW	-	-	8.6	652	104	94	1399	797	29.0	0.58	47.4	-	-
	1700	103	TU	-	-	-	-	-	-	-	-	24.4	0.76	44.2	4.0	7.0
	2400	104	SW	-	89	8.4	680	65	42	1050	-	29.8	0.40	48.1	5.1	8.1
11/30/76	0845	105	SW	-	115	8.6	688	111	59	1162	948	31.3	-	47.7	5.3	8.5
	0845	106	LDC	-	-	-	1006	128	-	-	-	-	-	-	-	-
	1630	107	SW	-	111	8.8	712	87	41	937	-	29.8	0.07	46.8	3.6	6.0
	1630	108	TU	-	-	-	-	-	-	-	-	27.2	0.10	45.5	1.0	1.8
	2200	109	SW	-	107	8.8	680	92	26	1257	-	29.6	0.04	47.8	4.7	7.6

EPA Form 2350-4 (4-80)
(PREVIOUSLY CIN. EPA FORM 287)
U.S. GOVERNMENT PRINTING OFFICE 1980-

TABLE C-1
CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
12/1/75	0845	110	SW	-	114	8.7	702	91	50	1365	920	29.5	0.16	47.8	5.8	9.2
	0845	111	LDC	-	-	4.6**	976	107	1336	1000	-	-	-	-	-	-
	1630	112	SW	-	114	8.7	726	66	66	825	-	29.4	0.06	48.3	2.7	4.4
	1630	113	TU	-	-	-	-	-	-	-	-	25.9	0.04	44.8	0.5	1.0
	2130	114	SW	-	106	8.6	694	82	50	762	-	29.5	-	48.1	7.4	11.4
12/2/76	0900	115	SW	6.8	114	8.6	714	77	54	993	929	28.6	-	48.7	9.5	14.0
	0900	116	LDC	-	-	-	1038	95	1496	906	-	-	-	-	-	-
	1700	117	SW	7.1	114	8.9	694	75	38	873	-	28.4	-	46.5	7.1	11.3
	1700	118	TU	-	-	-	-	-	-	-	-	25.8	-	47.1	5.6	9.0
	2200	119	SW	-	110	8.7	718	75	43	867	-	30.1	-	48.0	5.8	9.1
12/3/76	0845	120	SW	-	118	8.6	749	55	46	919	914	29.8	-	48.1	6.6	10.2
	0845	121	LDC	-	-	4.4**	1113	77	1480	1054	-	-	-	-	-	-
	1600	122	SW	-	116	8.4	738	43	45	1870?	914	29.25	-	47.2	7.76	12.0
	1600	123	TU	-	-	-	-	-	-	-	-	28.57	.04	46.6	12.57	18.4
	2200	124	SW	6.7	115	8.7	762	41	48	1131	-	-	-	-	-	-
12/4/76	0845	125	SW	7.5	112	8.6	694	53	72	742	905	29.5	-	49.0	4.8	7.5
	0845	126	LDC	-	122	4.8	1052	79	1504	900	-	-	-	-	-	-
	0845	127	TU	-	-	-	-	-	-	-	-	29.6	-	47.9	7.0	10.9
	0845	128	SW	6.8	112	8.2	637	49	49	686	879	28.5	0.1	47.9	4.9	7.9
12/5/76	0900	129	LDC	-	110	5.2	944	79	1405	688	-	-	-	-	-	-
	0900	130	TU	-	-	-	-	-	-	-	-	29.8	0.1	49.2	4.7	7.4
12/6/76	0830	131	SW	-	118	7.4	579	63	93	700	853	29.4	0.2	48.9	6.5	10.0
	0830	132	LDC	-	116	5.0	951	65	1568	638	-	-	-	-	-	-
	1700	133	SW	6.8	119	9.0	634	10	53	664	-	29.9	0.05	49.3	6.80	10.3
	1700	134	LDC	-	122	5.0	936	46	1408	718	-	-	-	-	-	-
	1700	135	TU	-	-	-	-	-	-	-	-	33.0	-	48.7	7.7	11.6
12/7/76	0900	136	SW	7.1	119	8.3	713	38	50	600	874	32.5	-	48.8	5.5	8.6
	0900	137	LDC	-	122	4.8	1109	65	1550	495	-	-	-	-	-	-
	1600	138		6.8	119	8.2	714	58	60	620	-	31.9	0.6	48.4	2.4	4.0
	1600	139	LDC	-	116	5.0	980	50	1070	125	-	-	-	-	-	-
	1600	140	TU	-	-	-	-	-	-	-	-	33.4	.07	49.6	1.7	2.8
	2200	141	SW	7.3	117	8.2	693	60	40	585	-	32.9	.07	48.9	5.5	8.6
	2200	142	TU	-	-	-	-	-	-	-	-	32.6	.08	49.2	5.4	8.4

**filtered

TABLE C-1
CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^-	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
12/ 9/76	0830	143	SW	3.5	119	8.1	785	65	55	1051	822	33.1	-	47.95	5.93	9.3
	0830	144	LDC	-	126	4.7	1280	80	1636	1020	-	-	-	-	-	-
	0830	145	TU	-	-	-	-	-	-	-	-	33.1	-	48.71	6.23	9.6
	1700	146	SW	3.4	118	7.9	640	60	55	939	-	32.6	-	47.8	5.8	9.2
	1700	147	TU	-	-	-	-	-	-	-	-	32.9		48.5	6.2	9.6
	2200	148	SW	2.9	117	8.0	836	70	80	1300	-	29.6	0.0	47.9	5.4	8.6
	2200	149	TU	-	-	-	-	-	-	-	-	29.9	0.0	46.9	7.9	12.3
	2200	150	LDC	-	118	4.8	1237	-	1490	1280	-	-	-	-	-	-
12/10/76	0900	151	SW	3.2	116	8.0	852	40	45	1230	844	29.8	-	46.1	8.4	13.2
	0900	152	TU	-	-	-	-	-	-	-	-	29.0	-	46.1	9.3	14.4
	1800	153	SW	3.1	118	8.4	824	80	60	1300	863	29.7	0	46.4	6.85	10.9
	1800	154	LDC	-	120	4.8	1210	85	1505	1240	-	31.5	.05	41.65	-	-
12/11/76	0930	155	SW	3.1	118	8.0	820	90	50	1325	815	30.28	-	46.3	2.16	3.7
	0930	156	LDC	-	118	4.7	1180	100	1390	1470	-	29.2	0.2	42.1	12.2	19.5
12/12/76	0930	157	SW	3.0	120	8.2	792	80	65	1850	837	29.7	-	46.0	9.0	14.0
	0930	158	LDC	-	123	4.6	1176	106	1410	1760	-	29.7	-	45.3	8.6	13.7
12/13/76	1400	159	SW	3.1	116	8.0	752	106	48	1223	863	29.7	0	47.8	5.4	8.6
	1400	160	LDC	-	119	4.7	1128	101	1471	1331	-	30.0	-	45.2	5.7	9.5
12/14/76	0900	161	SW	3.0	117	7.8	772	95	63	1280	872	29.6	<0.1	46.3	8.3	13.0
	0900	162	LDC	-	122	4.8	1162	101	1600	1265	-	29.6	<0.1	46.0	9.4	14.6
	0900	163	TU	-	-	-	-	-	-	-	-	28.5	0.07	44.8	7.6	12.4
	1600	164	SW	2.8	116	8.1	750	91	53	1214	-	29.6	< 0.01	47.4	8.7	13.3
	1600	165	LDC	-	-	-	1148	109	1568	1347	-	30.1	< 0.01	45.8	10.2	15.7
	2100	166	SW	2.9	116	8.1	672	-	46.6	1244	-	29.7	< 0.1	46.7	5.9	9.5

TABLE C-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^=$	$SO_4^=$	Cl^-	Ca^{++}	Mg^{++}	$SO_3^=$	$SO_4^=$	Oxidation
12/15/76	0915	167	SW	3.4	118	8.1	738	96	59	1136	861	29.5	<0.1	47.0	6.7	10.6
	0915	168	LDC	-	124	4.8	961	92	1099	1275	-	29.5	<0.1	47.2	7.1	11.1
	1800	169	SW	3.0	-	-	664.8	101.4	65.3	1140	-	29.4	0.12	47.7	8.7	13.2
	1800	170	LDC	-	-	-	930.4	95.6	1051	1310	-	30.9	<0.01	46.1	6.6	10.7
	1800	171	TU	-	-	-	-	-	-	-	-	28.5	0.18	46.4	8.6	13.4
12/16/75	0900	172	SW	5.3	117	8.2	587	85	61	801	846	-	-	-	-	-
	0900	173	SW-E	-	117	7.6	877	107	2	1511	855	-	-	-	-	-
	1900	174	SW	-	117	8.3	500	76.2	63.7	587	-	29.7	0.0	48.9	5.7	8.9
	1900	175	LDC	-	-	-	802	93.4	1369	486	-	-	-	-	-	-
12/17/76	1030	176	SW	7.1	117	8.2	504	64	64	558	765	29.7	<0.1	48.9	5.7	8.9
	1030	177	LDC	-	122	4.8	824	90	1505	650	-	-	-	-	-	-
	1800	178	SW	9.5	117	8.0	488	63.1	53.1	571.4	-	29.8	<0.1	49.8	5.2	8.0
	1800	179	LDC	-	-	-	824	95.1	1608	537	-	-	-	-	-	-
12/18/76	0800	180	SW	7.0	117	8.1	479	68.4	79.7	556.3	-	29.6	<0.01	49.4	5.3	8.2
	0800	181	LDC	-	-	-	808	101.9	1512	596	-	-	-	-	-	-
12/19/76	0900	182	SW	7.1	117	8.1	488	62	55	551	791	29.8	<0.1	49.8	4.8	7.4
	0900	183	LDC	-	124	4.8	808	83	1423	647	-	-	-	-	-	-
12/20/76	0900	184	SW	7.0	118	8.4	464	66	76	431	778	29.8	<0.1	50.0	4.2	6.5
	0900	185	LDC	-	124	5.0	808	92	1624	458	-	-	-	-	-	-
	1800	186	SW	8.6	116	8.4	457	53	52	549	-	29.9	<0.01	50.66	4.7	7.2
	1800	187	LDC	-	-	-	784	83	1498	566	-	-	-	-	-	-
	2200	188	SW	7.2	-	-	472	39	44.1	592	-	29.8	<0.1	49.7	5.6	8.6
	2200	189	LDC	-	-	-	891	90	1482	518	-	-	-	-	-	-
12/21/76	0930	190	SW	7.0	115	8.4	490	70	50	508	834	29.7	<0.1	50.0	5.6	8.5
	0930	191	LDC	-	118	4.8	841	87	1498	665	-	-	-	-	-	-
	1700	192	SW	-	-	-	528	67	52	654	-	30.08	<0.1	49.5	6.4	9.7
	1700	193	LDC	-	-	-	792	73	1410	615	-	-	-	-	-	-

Chronology of Phase I - Waste Disposal Operations

C-E waste disposal supervision arrived at Paddy's Run on 10/20/76, to assist in completion of the waste disposal mixing station. C-E waste disposal personnel arrived on site on 10/25/76 to participate in mixing system calibration and shakedown. Actual calibration runs were delayed until noon on 11/2/76 due to completion of final construction details on screw conveyors, slurry flowmeter and slurry circulating pump installations.

All equipment checkout and calibrations necessary for mixing operations were completed on 11/15/76. See Supplement C-I for details.

I. Preparation of Test Mixes

Mix #1 (See Table C-2)operations were begun on 11/4/76.
The 24% slurry was taken directly from the thickener underflow and pumped through a 1-1/2" magnetic flowmeter into the Bauer mill feed screw. Fly ash and fixative were metered into the mill feed screw along with the slurry flow. Two trucks were available for loading. The first truck to start loading developed a tailgate leak. Loading was stopped and new tailgate gasketing installed. Both trucks were then loaded with Mix #1.

Mixing system operations were discontinued until 11/8/76 to await completion of above ground impoundments and installation of leachate sampling systems. The two loaded trucks were stored in a Quonset Hut at Paddy's Run station until 7:00 AM, 11/8/76, when they were sent to the Cane Run demonstration pond site for unloading.

Preparation of Mix #1 resumed on 11/8/76 and a total of 17 truckloads were required to fill swimming pool #1 and in-ground pond #1 (Figure C-3). Mix #1 operations were completed on 11/11/76. Installation of the filter press was begun on 11/3/76 and completed on 11/9/76.

Pressure filter press shakedown and calibration tests were conducted from 11/3/76 through 11/19/76.

Mix #4

Mixing systems operations were initiated on 11/19/76 to fill swimming pool #2 and were completed on 11/23/76 amid several mixing system materials handling equipment modifications and improvements. Mix #4 operations consisted of running the filter press slurry pump feed pressure up to 120 psig using two Wilfey pumps up to 100 psig and finishing with the Graco pump which requires 20 to 25 minutes to complete the filtration cycle. Fifty to sixty minutes/batch were required to move the filter cake from the filter press surge hopper through the 6" conveyor to the Bauer mixer. Much hand persuasion and shoveling were required to minimize cake bridging in the hopper and to control cake feed to the screw conveyor. Twenty-eight filter press batches were required to fill the small pond #2.

Calibration of the "Quickee" moisture determinations (See Supplement C-I) on Mix #4 filter cakes compared to oven-dried samples shows that the "Quickee" method results are generally about 4% lower in moisture than the oven method.

Mix #2

Mix #2 operations were initiated on 12/3/76 following the slurry line thawing and clearing operations necessitated by the freezing temperatures encountered during the mixing system shutdown over Thanksgiving weekend. A total of 118 filter press batches were required to fill Pit #2 (large pond) and Pool #3 (small pond). Eighty-five batches went into the pit and 33 batches went into the pool. Much less strenous hand persuasion was needed to keep the filter cake from building in the hopper and to control cake feed to the screw conveyor. Mixing operations were conducted on a 7-day week, 24-hour day basis and completed on 12/8/76.

Mix #6

Due to continuing difficulty in the materials handling system to the Bauer mill, LG&E and C-E agreed to try using a cement mixing truck to prepare

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Mix #6 and transport to the pond, thus bypassing the Bauer mill. Two questions were to be answered:

1. Is the mixing adequate?
2. Is mixing system capacity improved sufficiently to warrant use for Phase II operations?

Mix #6 operations were begun on 12/9/76 and completed on 12/11/76 to prepare 28 filter press batches to fill Pool #4. A summary of cake and mixture sample data are shown in Table C-2. Simultaneous feeding of fly ash and cake to the cement truck caused severe blockage of the cement mixer inlet. Alternate feeding of filter cake and fly ash was necessary to feed materials to the cement mixer. Truck unloading proved to be a laborious, time-consuming job. In some truck loads, it was necessary to add up to 1500 # of additional fly ash to the mixer to get the mixture to discharge into the cement truck discharge chute. The results of the cement mixing truck test were:

1. Mixing was found to be marginal,
2. Mixing capacity was not improved and,
3. Mix composition for discharge from the cement truck appears to be outside the range of mixtures to be used to fill the test ponds.

The conclusion of all parties involved in the test program indicates that the cement mixing truck is not suitable for Phase II of the test program.

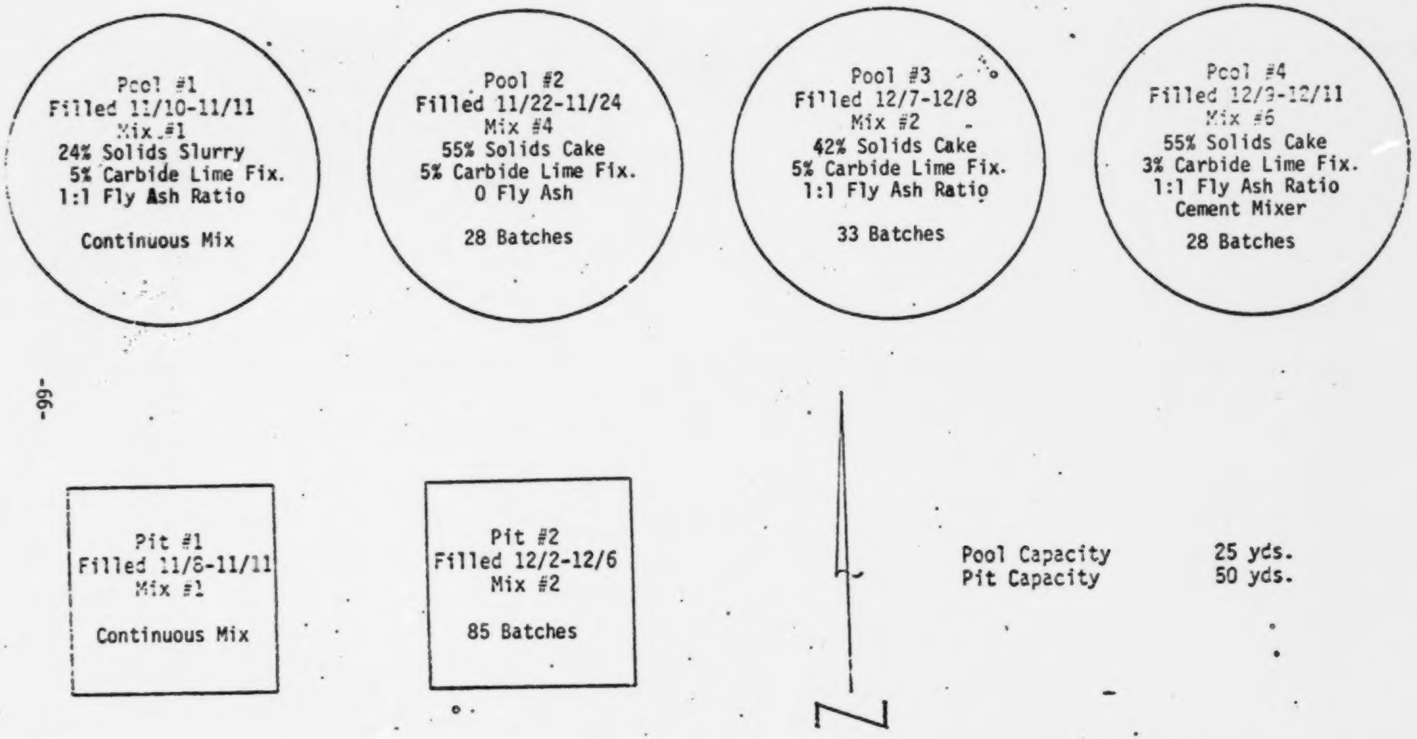
II. Settling and Filter-Leaf Tests

Thickener underflow settling and filter-leaf tests were conducted throughout the Phase I test period. Initial settling tests run during the startup and steady-state attainment periods resulted in separation of the solids portion into two distinct phases. The heavier was black, while the other was light gray. Analyses of these solids showed magnesium present in larger than normal steady-state quantities. These results required Airco (the additive carbide lime supplier) to change its materials processing procedures to exclude the magnesium fraction taken from the carbide process-off gas scrubbing system.

The data from the settling and filter-leaf tests are shown in Table C-3. A typical plot of the settling data is shown in Figure C-4. All settling rates were well within the capacity of the thickener.

SLUDGE IMPOUNDMENT SITE

PHASE I Carbide Lime


Pool #1
Filled 11/10-11/11
Mix #1
24% Solids Slurry
5% Carbide Lime Fix.
1:1 Fly Ash Ratio
Continuous Mix
Pool #2
Filled 11/22-11/24
Mix #4
55% Solids Cake
5% Carbide Lime Fix.
0 Fly Ash
28 Batches
Pool #3
Filled 12/7-12/8
Mix #2
42% Solids Cake
5% Carbide Lime Fix.
1:1 Fly Ash Ratio
33 Batches
Pool #4
Filled 12/9-12/11
Mix #6
55% Solids Cake
3% Carbide Lime Fix.
1:1 Fly Ash Ratio
Cement Mixer
28 Batches
Pit #1
Filled 11/8-11/11
Mix #1
Continuous Mix
Pit #2
Filled 12/2-12/6
Mix #2
85 Batches
N

Pool Capacity	25 yds.
Pit Capacity	50 yds.

Figure C-3

TABLE C-2

Mix #	Average % Solids Cake	Average % Solids Mix	Range % Solids Cake	Range % Solids Mix	Aug. Fly Ash Ratio In Mix	Nominal Mix Composition
1	N.T.	40 (20 samples)	N.T.	36-50	1:1	24% thickener underflow solids slurry 1:1 fly ash ratio 5% carbide lime fixative 39.3% solids in mix
2	38.9 (31 samples)	58.8 (31 samples)	36-47	56-65 (31 samples ea.)	1:1	42% solids cake 5% carbide lime fix 1:1 fly ash ratio 59.75% solids in mix
4	N.T.	54 (12 samples)	N.T.	49-60	0:1	55% solids cake 5% carbide lime fix 0% fly ash 56.2% solids in mix
6	52 (28 samples)	N.A. (28 samples)	41-58	N.A.		55% solids cake 0% fixative 1:1 fly ash ratio 71% solids in mix

N.A. = not available
N.T. = not taken

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Supplement C-I

Equipment Checkout and Calibration

Shakedown and familiarization checkout of the equipment arrangement and and piping circuits was begun on 10/27/76. Calibration of the fixative feed hopper and the 4" fly ash conveyor was begun on 11/2/76.

Calibration of the fixative feed hopper consisted of obtained fixative flow rates (#/min) at several feeder controller settings. These time-weight delivered readings are repeated several times to obtain average readings at identical control settings. The data were then plotted on a flow rate versus control setting chart which was used to obtain the necessary control settings for desired mixing flow rates.

Calibration of the 4" fly ash screw conveyor consisted of obtaining time-weight delivered data using a 55 gallon drum to collect and weigh the fly ash delivered at several different speed settings (RPM) of the variable speed drive. The time-weight data were repeated several times to assure repeatability when the speed settings were reset on the drive control. These data were then averaged and plotted on a flow rate versus RPM chart which was used to obtain the necessary speed settings for desired mixing flow rates.

A rapid method to determine % solids in slurry, filter cake and mixer product was required to provide a mixing quality check of the mixing operation. The fastest method found was the "Quickie" soil moisture tests used to measure moisture in soils. The tester consists of a bottle which has a calibrated pressure gage and a seal cap. To obtain a moisture reading, the following procedure is followed.

1. Weigh 6.5 or 13 gram sample of mixture (depending on expected moisture content) and put sample in bottle.
2. Add two steel balls to bottle.
3. Put three special spoons full of calcium carbide powder into the seal cap of the bottle.
4. With bottle horizontal, put seal cap on bottle and lock in place.

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5. Shake bottle in rotary mixing motion to get steel balls to intimately mix the sample and the carbide.
6. The carbide reacts with all surface moisture present to form acetylene gas which causes the pressure gauge to read a % moisture.

Depending on the weight of the sample, the reading is multiplied by a factor to obtain the % moisture in the sample. % solids is then obtained by % solids = 100 - % moisture + deviation. This procedure usually takes less than 10 minutes to complete. Oven drying usually takes 4 or 5 hours. Daily oven-dried samples were taken to verify the deviation of the "Quickee" method from the more accurate oven dry method.

Calibration of the 6" filter cake conveyor was more difficult due to the problems of bridging and feeding cake to the screw conveyor. Actual calibration of the conveyor was done with 42% moisture cake which did not bridge easily and was easier to feed to the screw.

Shakedown of the filter press was started on 11/13/76 and completed on 11/15/76. The pump pressure and air drying cycles necessary to produce the desired cake % solids were determined. They were:

Pump Press	Time for Air Blow	% Solids Cake
80 psig	5 min.	43
100 psig	5 min.	52
120 psig		54+

Supplement C-II

Mechanical Difficulties & Solutions

A. Fly Ash Transfer and Feeding

The original fly ash handling system consisted of:

1. LG&E fly ash storage silo
2. air slide conveyor from silo to fly ash surge hopper
3. fly ash surge hopper with manual inlet and outlet valves
4. 4" screw conveyor & drive from fly ash surge hopper to Bauer mill feed screw shute.

Two problem areas were encountered in this system.

1. Fly ash transfer from the silo to the surge hopper was difficult to get started and to stop when the surge hopper was full.
2. Fly ash flow from the surge hopper to the 4" screw conveyor was erratic due to the high angle of repose character of fly ash causing "rat holing" at the hopper discharge.

Item 1 above appears to have been caused by the loss of integrity of the porous tiles between the air and solids sections of the air slide conveyor. When Phase I operations of the mixing station were completed, LG&E maintenance examined the full length of the air slide conveyor and found missing tile and fallen tile. These conditions caused the air slide to become a pneumatic conveyor with the resulting high surges in fly ash flow and carryover through the hopper caused by conveying air. This problem should be greatly reduced in Phase II operations since repairs to the air slide should eliminate the flow of air through the fly ash surge hopper.

Item 2 was resolved by renting and installing two cement compaction vibrators inside the fly ash surge hopper. "Rat holing" is minimized by intermittent operation of the cement vibrators.

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B. Bauer Mill Feed Screw

The Bauer mill had two problem areas:

1. inadequate horsepower on the mill feed screw drive motor causing frequent overloading and replacement of fuses,
2. bridging in the feed screw hopper whenever fly ash and coke were being fed simultaneously.

Item 1 was resolved after the original drive control card was burned out. A larger horsepower reversible drive motor was purchased and installed on 11/23/76. No further problems with Item 1 have been experienced.

Item 2 was discussed with C-E Bauer who recommended modification of the feed screw housing and the feed screw hopper to separate the fly ash and cake feed points to the screw to move the wet-dry interface as close to the mill plate as possible. Additional scraper bars would also be added to the rotating mill plate to keep the mix from accumulating inside the mixer housing and initiating plugging of the feed screw. The modifications were to made over the Christmas outage and to be completed by 1/10/77.

C. Filter Cake Surge Hopper

FCSH-Problems are the major "bottleneck" in the sludge mixing plant materials handling system. The original rectangular hopper had a rectangular inlet opening of 52"x72" and tapered to 7"x72" at the bottom where it discharged into a 6" screw conveyor.

The filter cake surge hopper is located directly under the filter press and when the press is opened, the cake drops from the filter leaves into the hopper. As the cakes dropped into the rapidly narrowing hopper, they would bridge over the discharge opening and the cake would not reach the feed screw without extensive manual pushing and prodding.

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Bin vibrators (4) were installed on the hopper to help reduce the bridging problem. The vibrators helped a little but did not resolve the problem. The hopper was modified on 11/16/76 to change the profile of the hopper slope from a \| (lazy Vee) to a shelf and slot ⌝|. This design prevented bridging and permitted controlled manual feeding of cakes into the vertical slot and the 6" screw conveyor. This system worked fairly well but required continuous manual feeding of the cake into the vertical slot.

Further improvement and modification of the filter cake surge hopper feed into the 6" screw conveyor is necessary for commercial operations. Several solutions were suggested and were investigated for possible inclusion in Phase II operations. The "live bottom bin conveyor" appears to be the most economical and practical solution to expedite Phase II operations.

This solution requires modification of the surge bin to feed a multiscrew conveyor (4 screws) that will discharge into the 6" conveyor. Purchase or rental of a multiscrew conveyor, with drive and installation with a circuit breaker would be necessary to accomplish this change.

D. Miscellaneous Problems

Cold weather (below freezing temperatures) operations caused two problems which could be resolved by heat tracing and insulating:

1. all pumped slurry piping and pumps and,
2. all compressed air actuated pumps and valves.

The slurry lines froze three times during Phase I operation, while the high pressure Graco pump air line froze twice at the pump.

The reducing gear drive assembly on the 4" fly ash conveyor had to be replaced after the drive worm broke when several bolts fed into the conveyor from the fly ash hopper. The new drive connection to the 4" screw was made with one brass bolt as a shear pin instead of the two steel bolts used originally.

DATE: 12/7/76

TIME: 9:50 Am

NOTES: ① .001129 ② .001146

TAKE SLURRY SAMPLE
FOR SOLIDS-LIQUID
ANALYSIS

	TIME ①	HT.	TIME ②	HT.
0	0	1000	0	997
	10	923	10	929
	20	852	20	860
	30	785	30	795
	45	690	45	703
1	60	600	60	620
	75	–	75	–
	90	440	90	460
	105	–	105	–
2	120	340	120	363
	150	290	150	300
3)	180	270	180	270
	210	265	210	268
		255		255

	①	②
WET. WT. OF TOTAL CYLINDER =	1651.7	1666.
− TARE WT. CYLINDER =	616.9	630.
A. WET WT. SLURRY =	1034.8	1035.
TOTAL WET WT. OF SETLLED SOLIDS =	932.2	944.
− TARE WT. CYLINDER =	616.9	630.
B. WET WT. OF SETTLED SOLIDS =	315.3	318.
TOTAL DRY WT. OF SOLIDS =	269.8	290.
− DRY DISH WT. =	200.0	220.
C. DRY WT. OF SOLIDS =	69.8	70.
% INITIAL SOLIDS = $\frac{C}{A}$	6.75	6.8
% UNDERFLOW SOLIDS = $\frac{C}{B}$	22.14	22.

Table C-3

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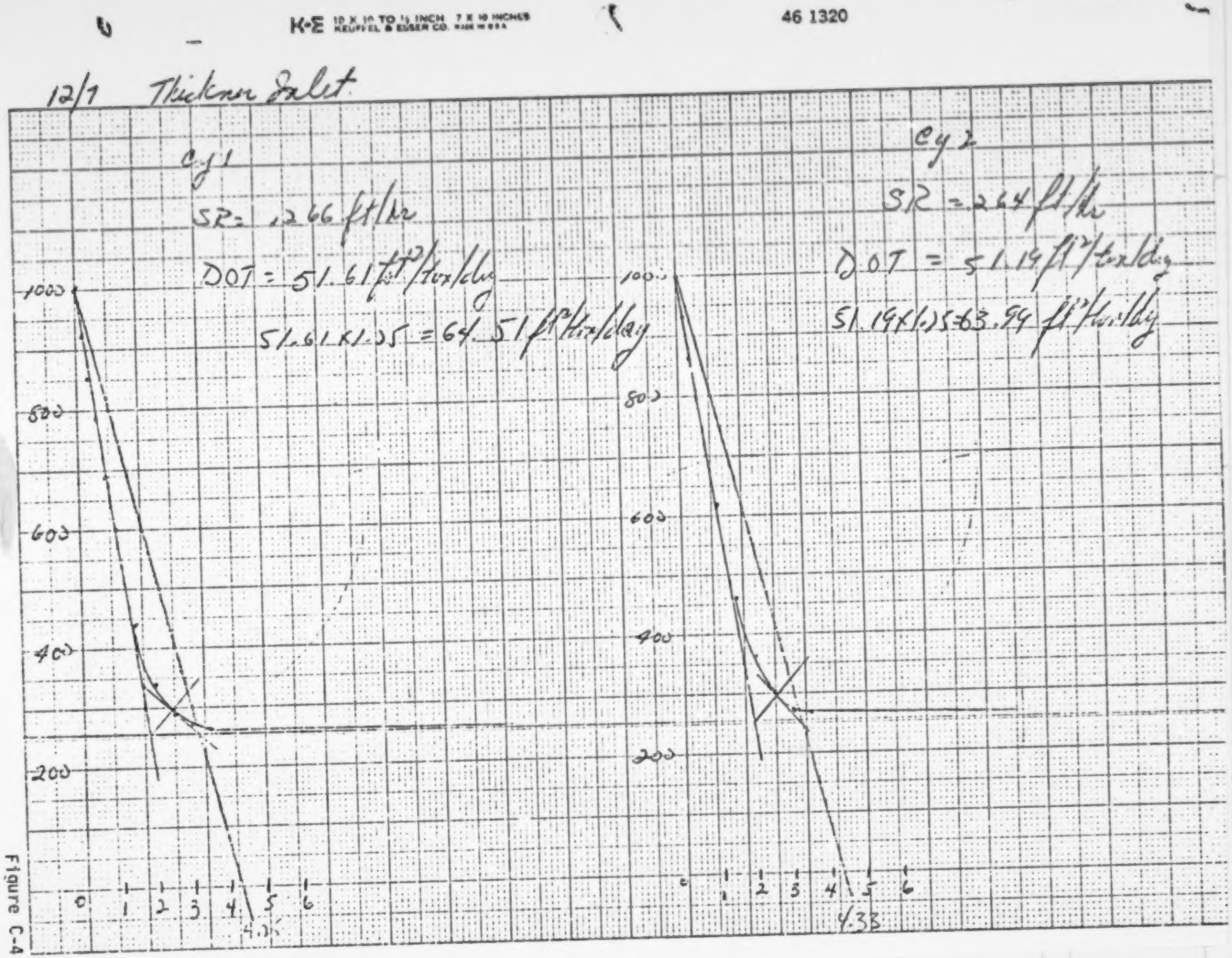

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Appendix D

Field Tests
Phase II
Discussion and Summary
Commercial Lime Experiments

March 10 to August 30, 1977

Introduction

The scrubber operation section details the assistance provided by C-E in continuous monitoring of liquid and solid phase chemistry to insure attainment of desired experimental conditions as well as to maintain scale-free operation of the AQCS.

The waste disposal section provides background on preparation of impoundment mixtures and preliminary field composition determinations.

Modification of the mixing train to include pneumatic feeding of fly ash into the mixer through the hollow shaft of the sludge feed-screw, reduced mixing time by more than half.

Reports are in preparation covering preliminary leachate analyses and compressive strength testing on the carbide lime impoundments as well as detailed commercial lime impoundment compositions.

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Scrubber Operation
C-E Assessment of Steady-State
Commercial Lime Test Phase

The recent characterization of the LG&E's Paddy's Run FGD System with commercial lime additive covered the approximate time period from March 10 to August 30, 1977. The commercial lime phase of the USEPA funded study included one extended 60 day shutdown and three shorter outage periods required for system maintenance and modifications. During the on-line time, on-site C-E personnel assisted LG&E in the operation of the FGD system coupled to Unit No. 6. The assistance provided included continuous monitoring of liquid and solid phase chemistry to insure attainment of desired experimental conditions and to avoid undesirable scale formation in the absorbers.

The narrative segment of this report chronologically summarizes the observations and results related to C-E's job function during the commercial lime test phase. The second portion, consisting of appendices, documents the specific chemical analyses data generated by C-E in fulfillment of its obligations during this phase of the study.

Base Commercial Lime Experiment (3/10-4/14/77)

The FGD System was initially operated using commercial lime additive on March 10, 1977. During the next three days chemical analyses of lower marble bed effluent indicated gypsum saturation levels capable of producing scale. On March 14 a visual inspection of the absorber internals verified the presence of gypsum scale - as had been expected from interpretation of the soluble system chemistry. During the following week the solids in the recirculating slurry were increased from about 6 to 12 percent in an effort to alleviate scaling conditions. While the increased solids did appear to reduce the calcium sulfate saturation, continued deposition of scale led to a shutdown of the system on March 21, 1977.

Following the March 23 discussion among the principals involved in the test program it was decided to restart the system on March 30, 1977. The system was operated in an open loop mode for a period of one week at the request of Radian Corporation - USEPA's principal contractor for the characterization study - on the supposition that an unidentified constituent was interferring with Radian's analytical procedure. On April 4 the system, having been purged of the alleged interferring species, was returned to closed loop operation. Chemical analyses of key process streams and visual inspection of the "B" absorber during the next few days indicated that the system was operating near critical scaling conditions. Localized calcium sulfate deposits were observed at several points in the absorber. Having established that the FGD System was incapable of subsaturated operation with commercial lime additive, the experiment was terminated on April 13, 1977.

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The failure to attain subsaturated operation, as required by the USEPA-Radian test plan, was discussed by the concerned parties on April 21 at Research Triangle Park, North Carolina. It was the collective opinion of those in attendance that magnesium addition presented the best possibility of attaining subsaturated operation. As a result, the commercial lime phase of the test program was restructured to include magnesium addition in all remaining commercial lime experiments.

Magnesium Addition Experiments (6/18-7/25/77)

On June 18, 1977 the FGD System was restarted for purposes of conducting magnesium addition experiments. The initial magnesium addition experiment, conducted at a magnesium concentration of approximately 2000 ppm, ultimately resulted in scaling of the absorber internals. The soluble magnesium level was increased to 4000 ppm on June 30. The system operated at extremely low levels of calcium sulfate saturation during the entire course of the experiment at 4000 ppm soluble magnesium. The FGD System was lined out and operated at stable conditions while the associated waste disposal studies commenced. The final magnesium variation experiment was conducted at a concentration of approximately 3000 ppm. This operating mode, initially attained on July 14, produced scale free operation until the termination of the experiment on July 25, 1977.

Draft Tube Effect Experiment (7/25-8/8/77)

During the period from July 25 to August 8, 1977 the system was operated with lime additive addition to the center of the main hold tank. (In all previous experiments, the calcium additives were introduced into the well mixed draft tube.) Magnesium addition continued and the system operated scale free at a concentration of 3000 ppm. On August 5 the soluble magnesium was decreased to about 2000 ppm. Interpretation of the chemical analyses data from August 7 and 8 indicated that gypsum saturation was approaching critical scaling levels. A visual inspection of the absorber internals on August 8, however, failed to disclose any evidence of significant scale formation.

Short Hold Tank Residence Time Experiment (8/16-8/24/77)

Following a one week outage for modifications, the FGD System was restarted on August 16. The lime additive addition point was returned to the draft tube and the hold tank residence time was reduced to 4-5 minutes by bypassing the main hold tank. During the period from August 16 to August 24, the magnesium concentration ranged from approximately 2200 to 3500 ppm. Difficulties in maintaining an adequate system water balance resulted in fluctuating magnesium levels and somewhat transient system operation during the course of this experiment. As a result, although system operation was generally subsaturated, two brief excursions producing supersaturated absorber effluent were observed.

Chloride Addition Experiments (8/24-8/30/77)

The final planned experiments in the commercial lime phase of the program entailed the addition of chloride to the system. Chloride, as $CaCl_2 \cdot 2H_2O$, was initially added to the FGD System surge tank on August 24, 1977. During the next five days the system ran in a stable, scale free mode at the reduced hold tank residence time and magnesium and chloride concentrations of 4000 and 3000 ppm respectively. Operational problems with the lime additive slaking operation, which resulted in a low solids fraction in the additive slurry, caused a premature termination of the final experiment by 36 hours.

At the conclusion of the formal test program on August 30, 1977 the FGD System was returned to carbide lime operation. Sampling and analyses of key process streams was performed on August 31, 1977, approximately 18 hours after returning to carbide lime operation, in order to ascertain the liquid phase system response.

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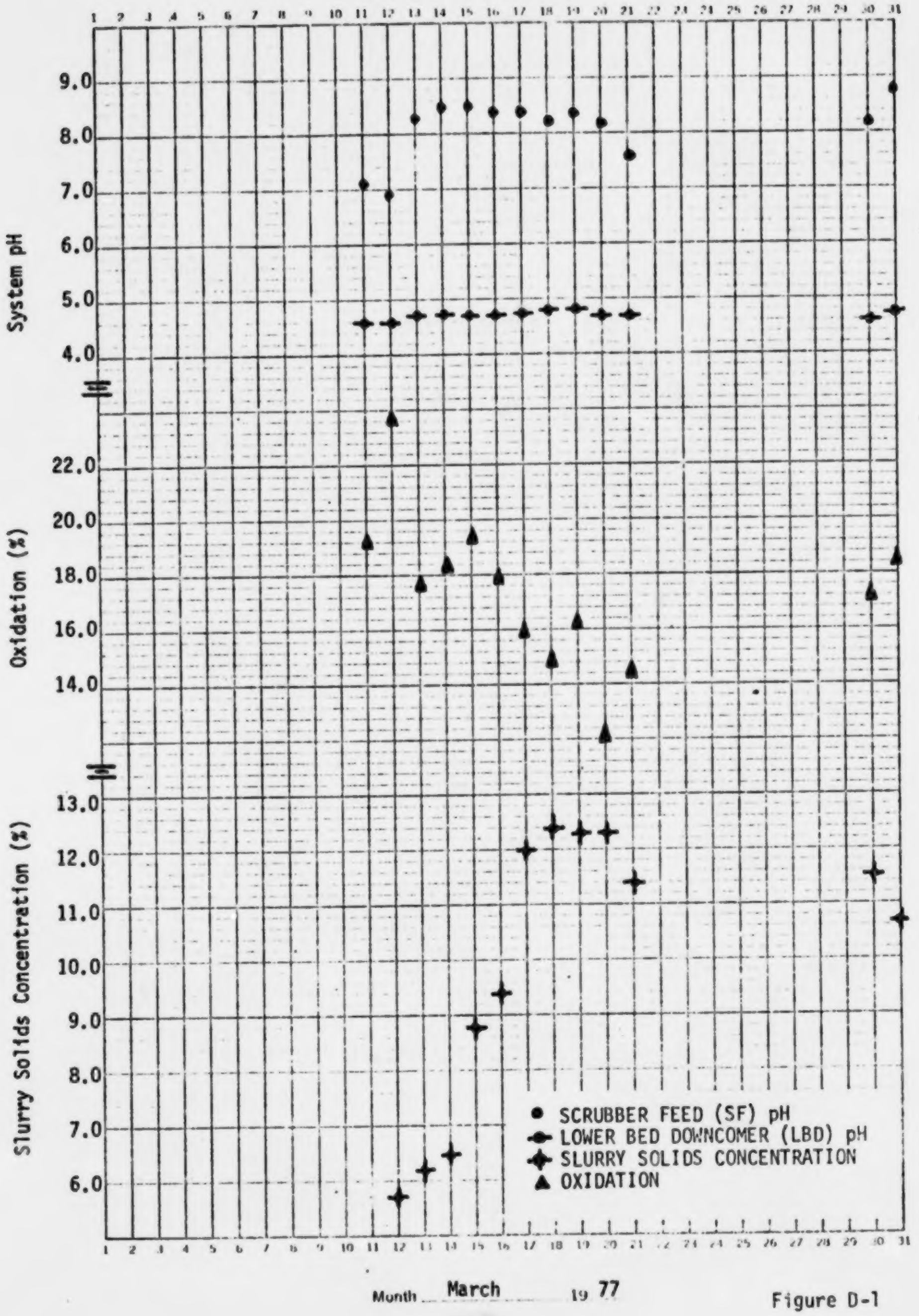

Figure D-1

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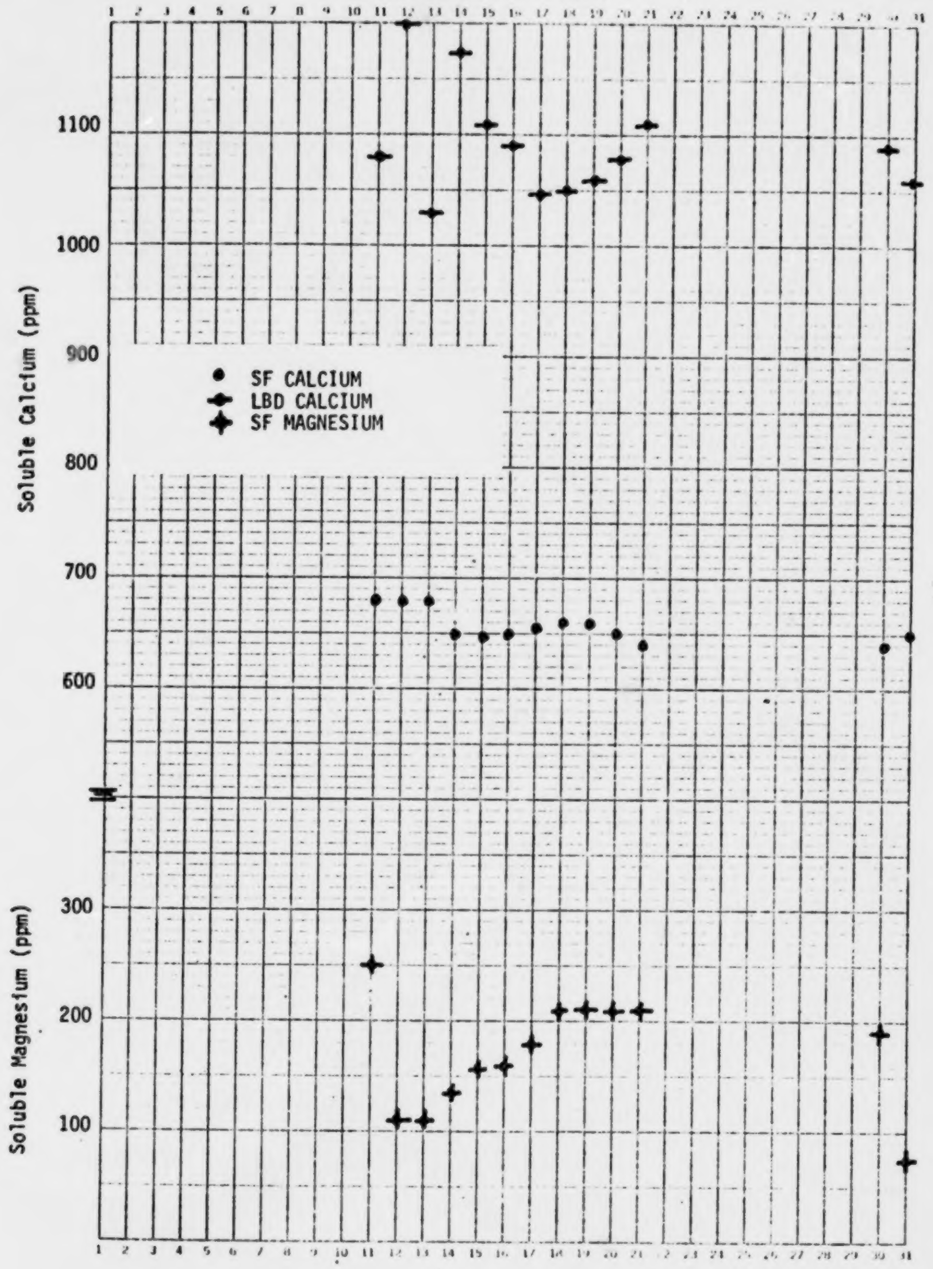

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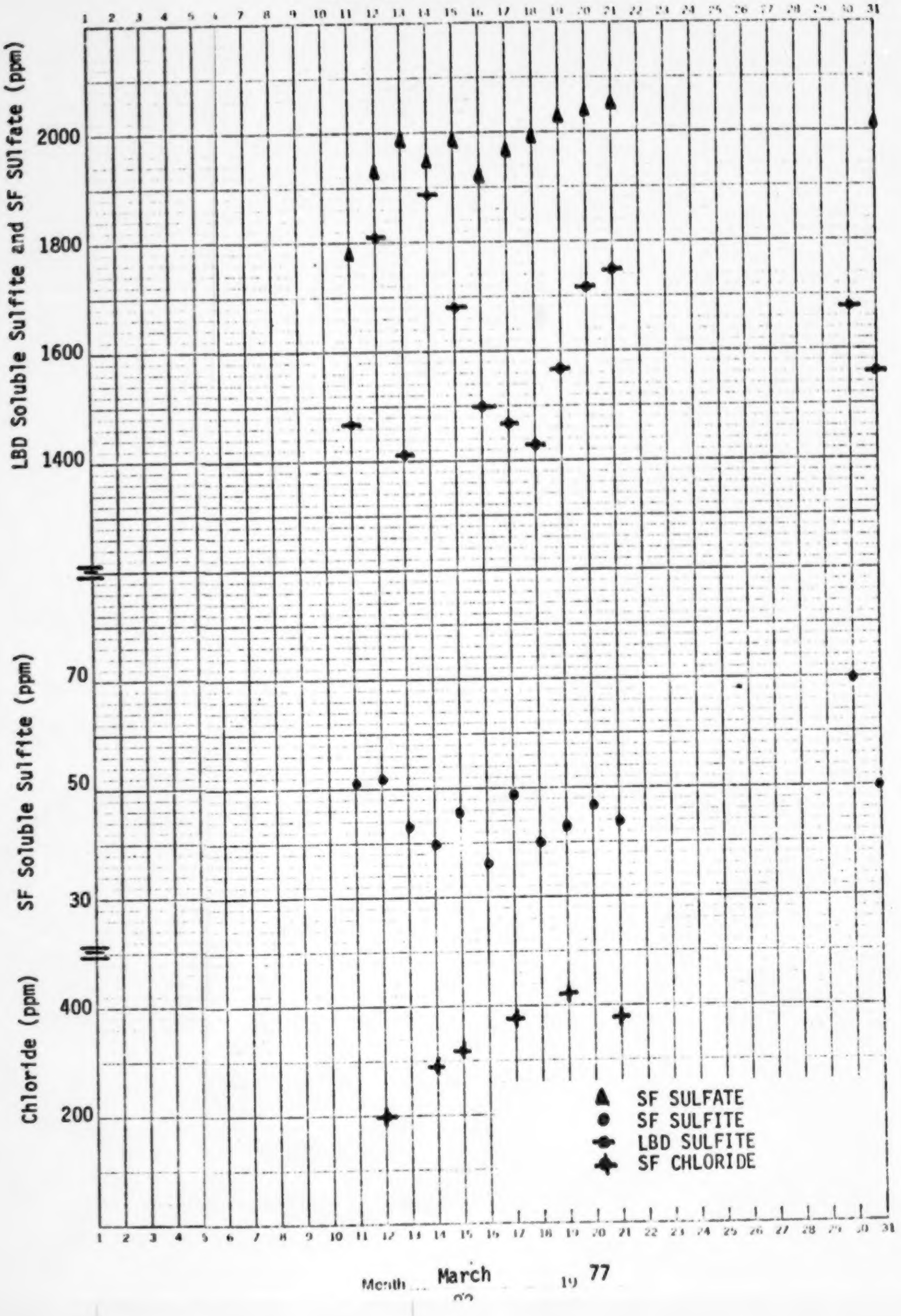

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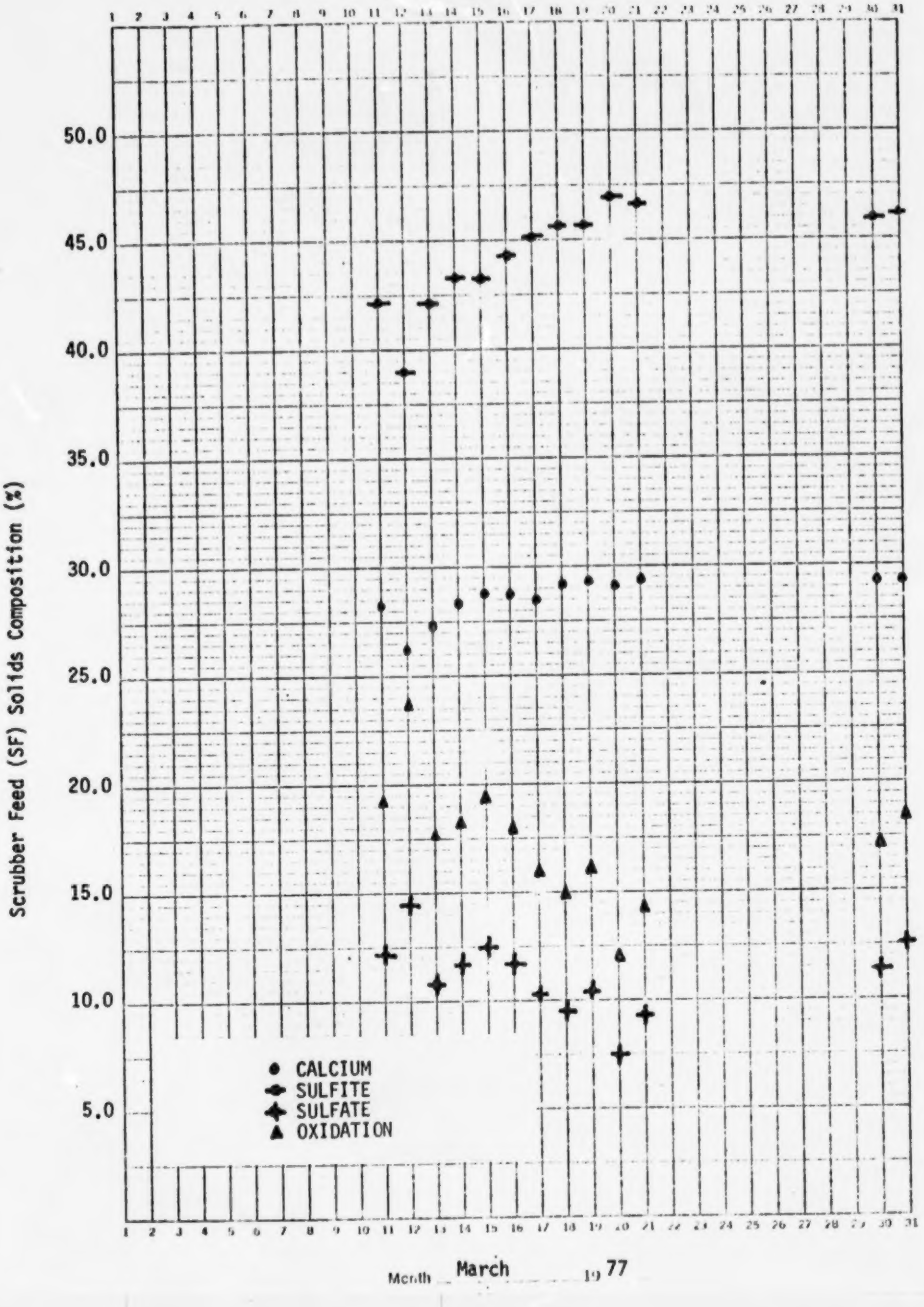

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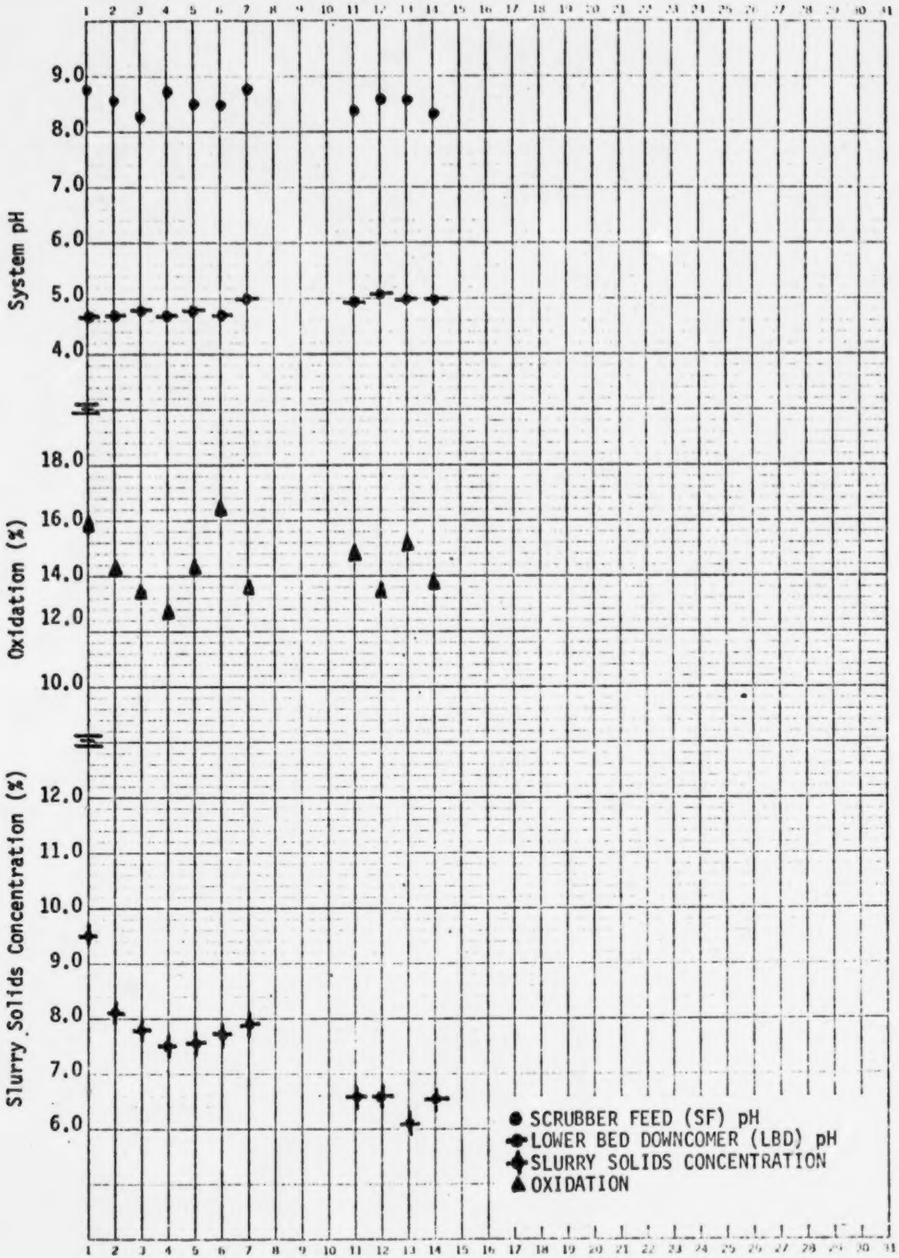

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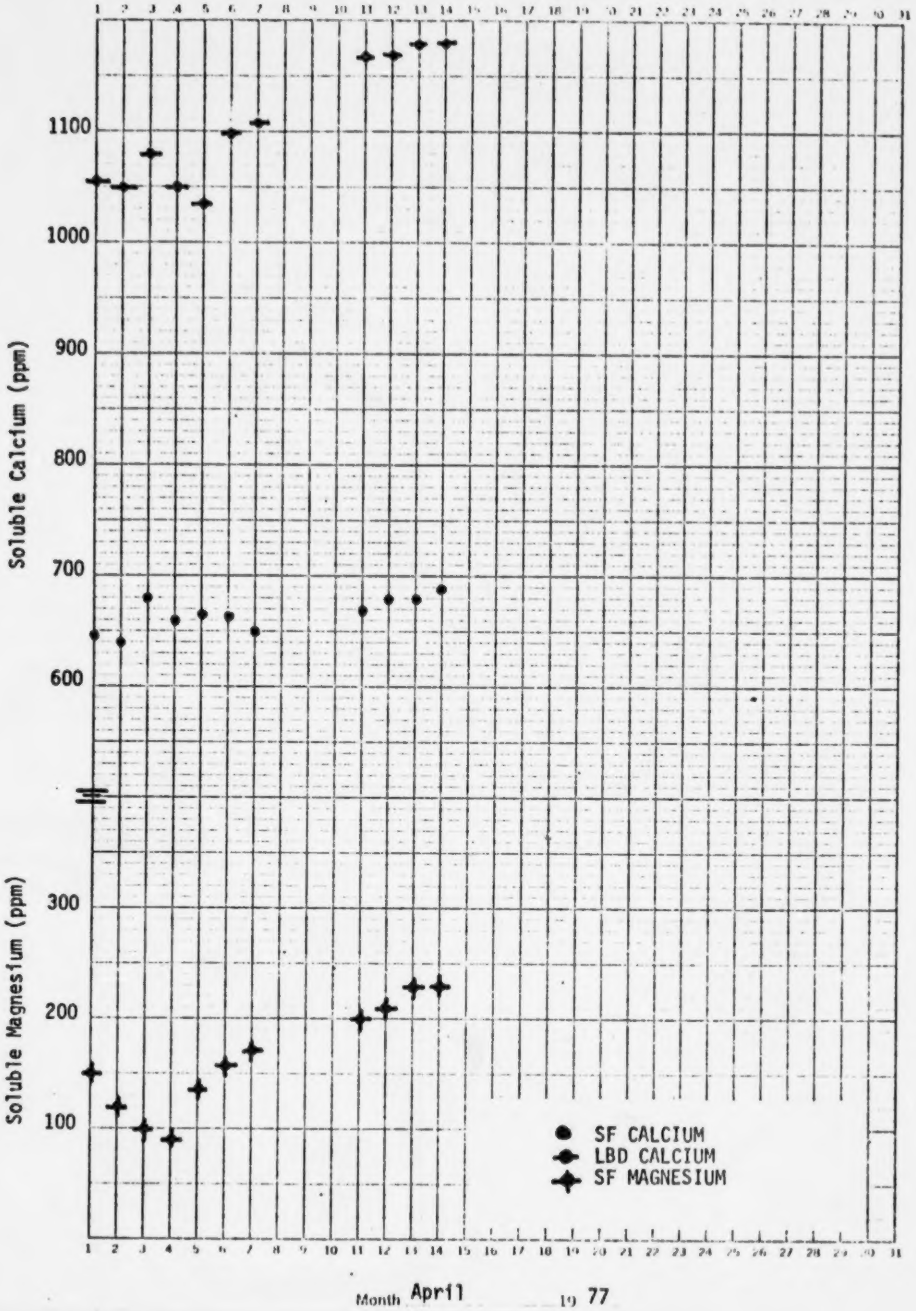

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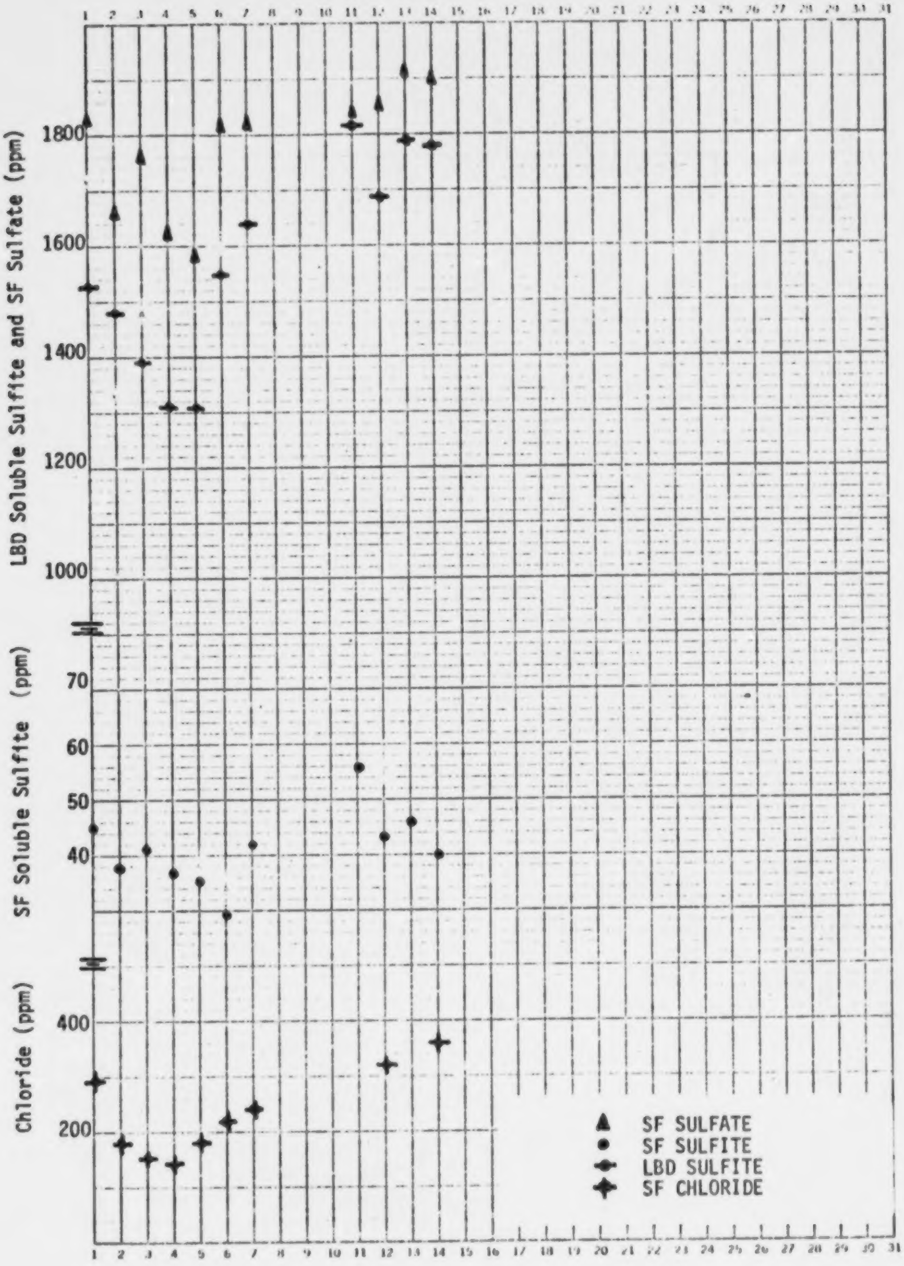

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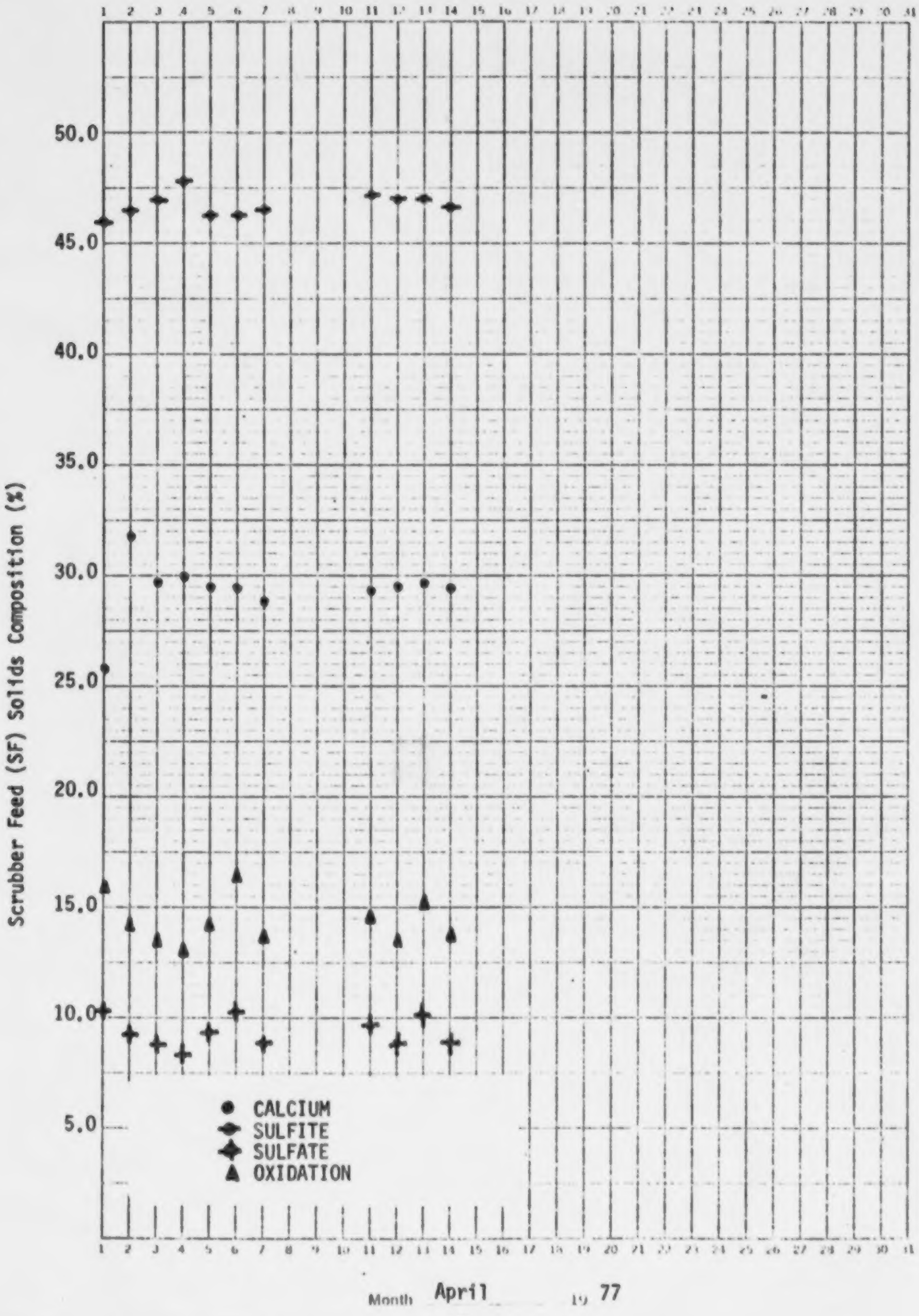

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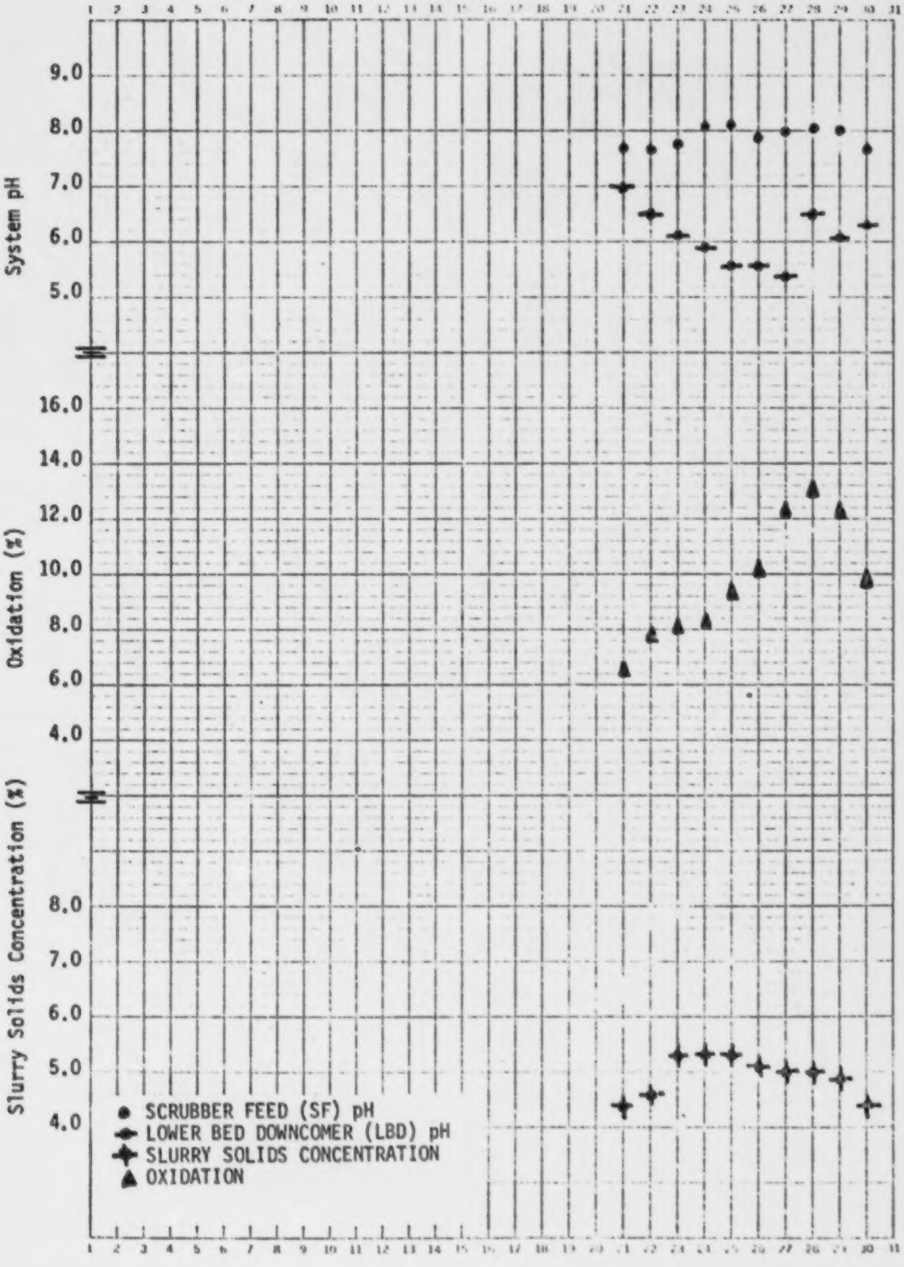

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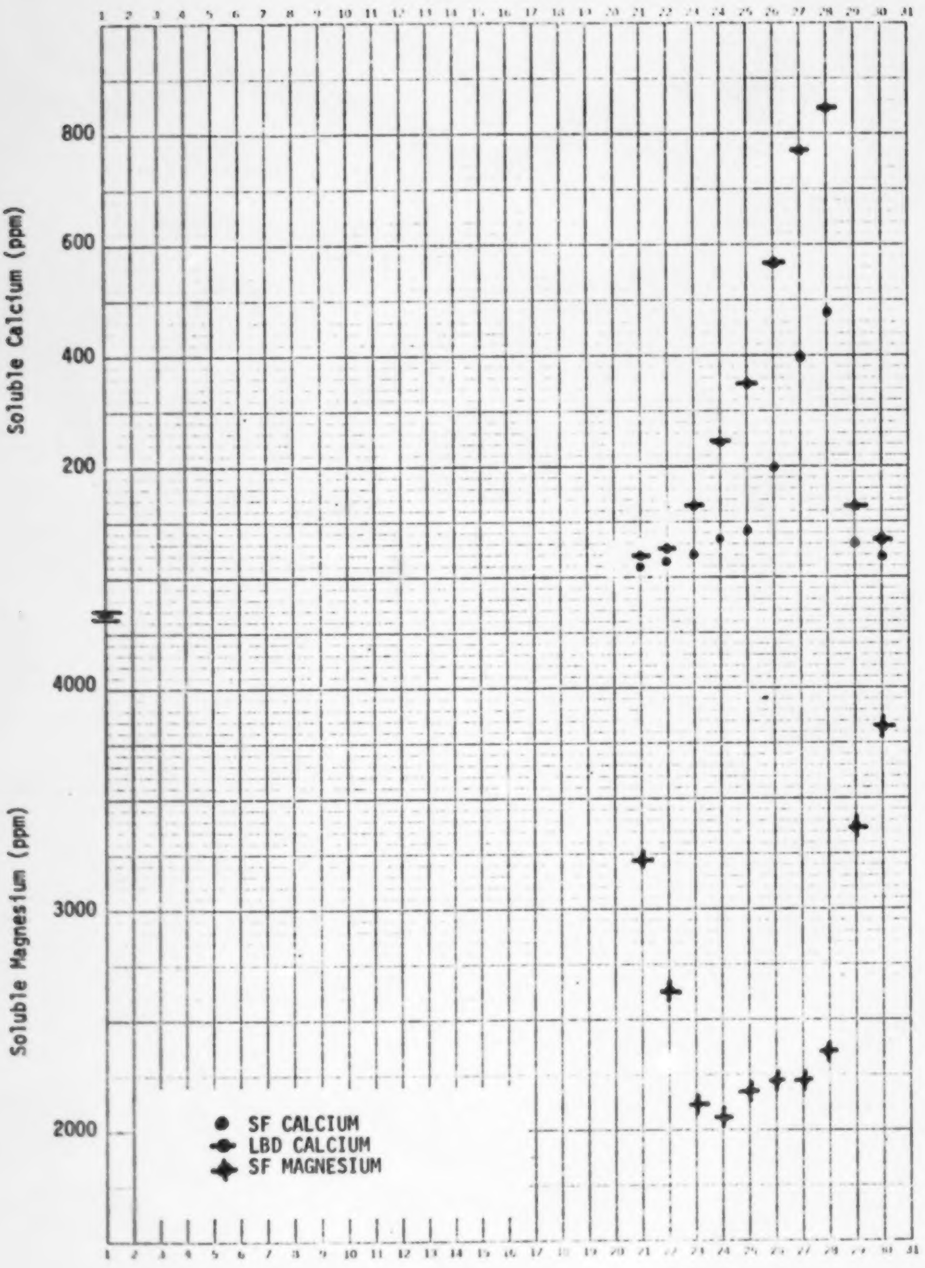

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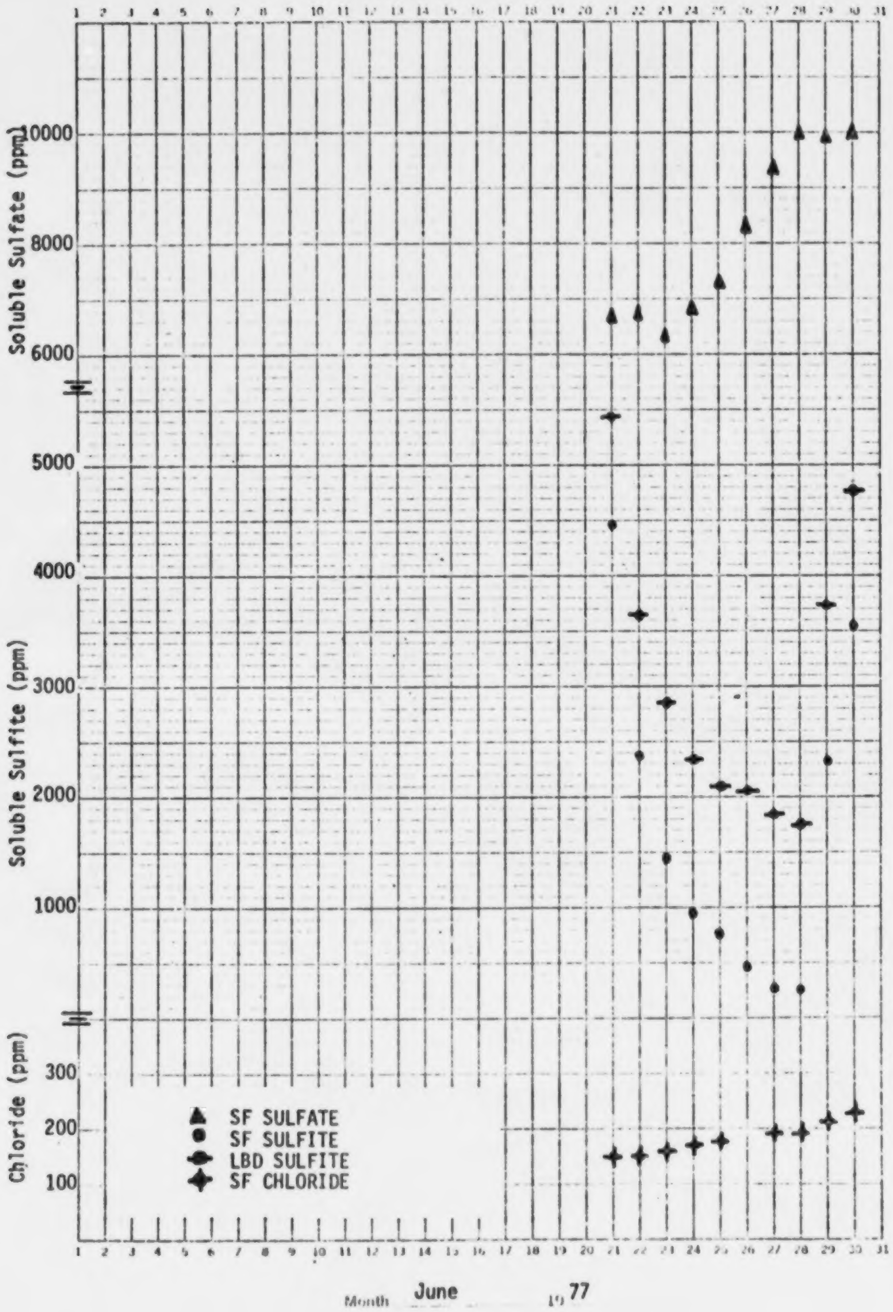

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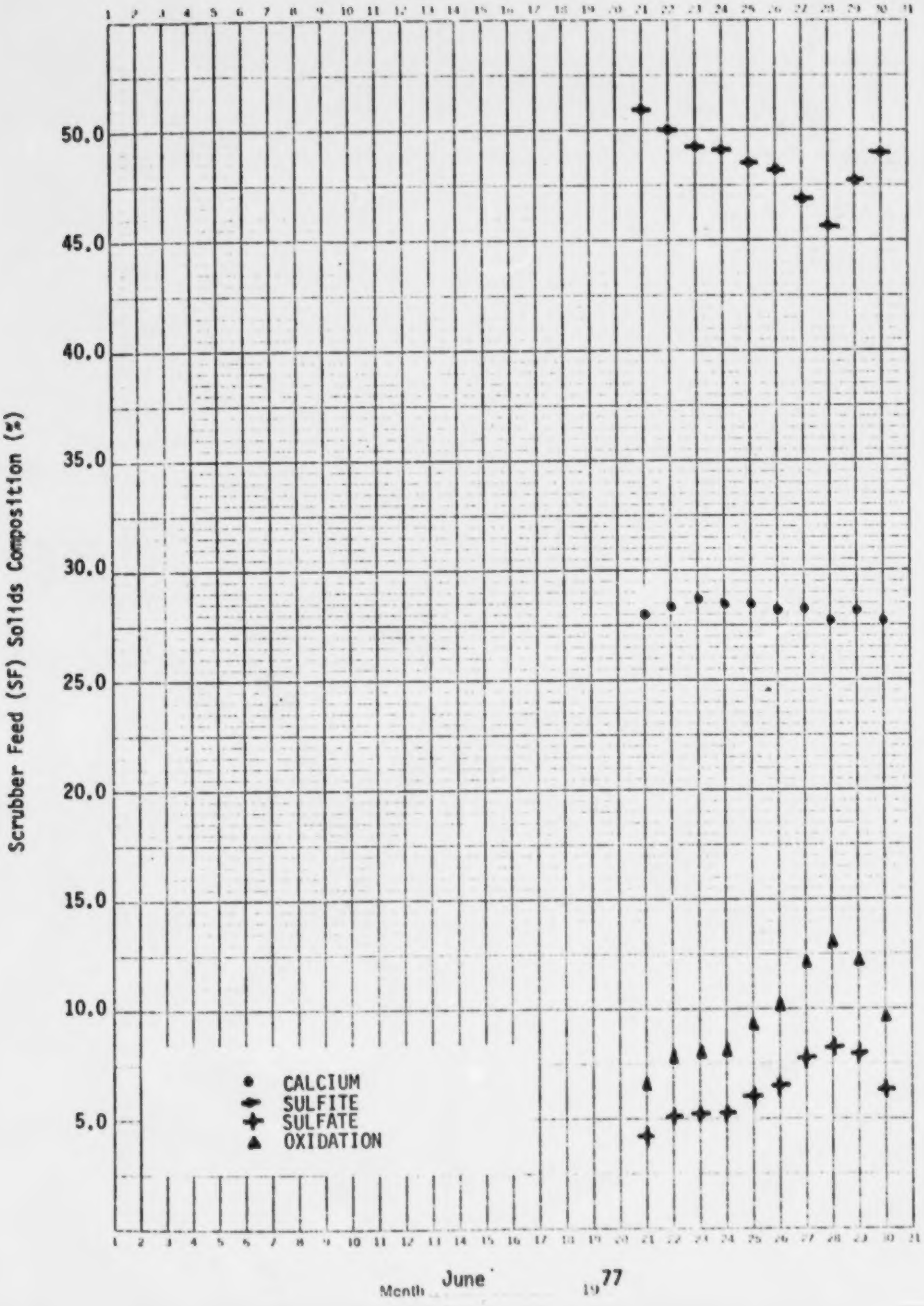

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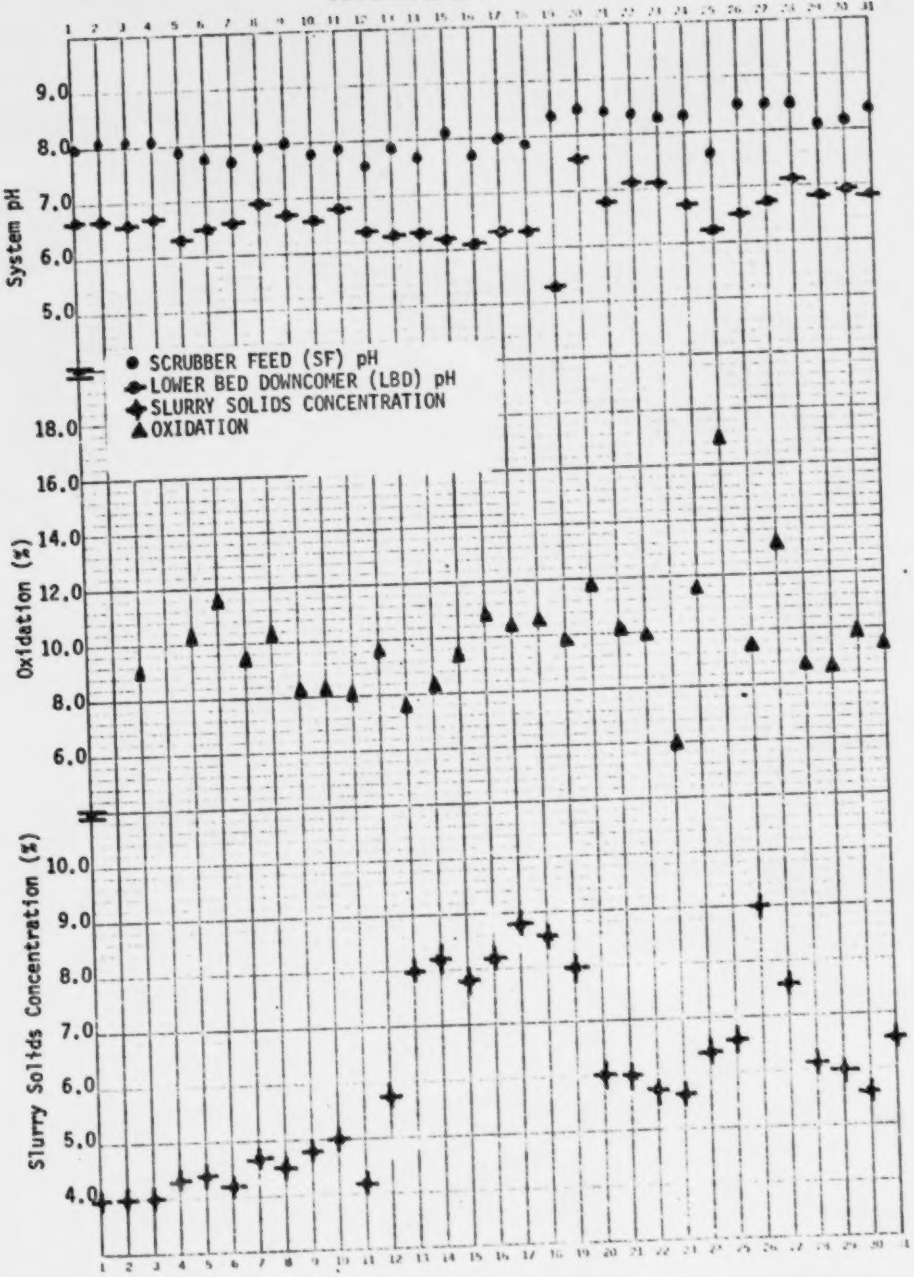

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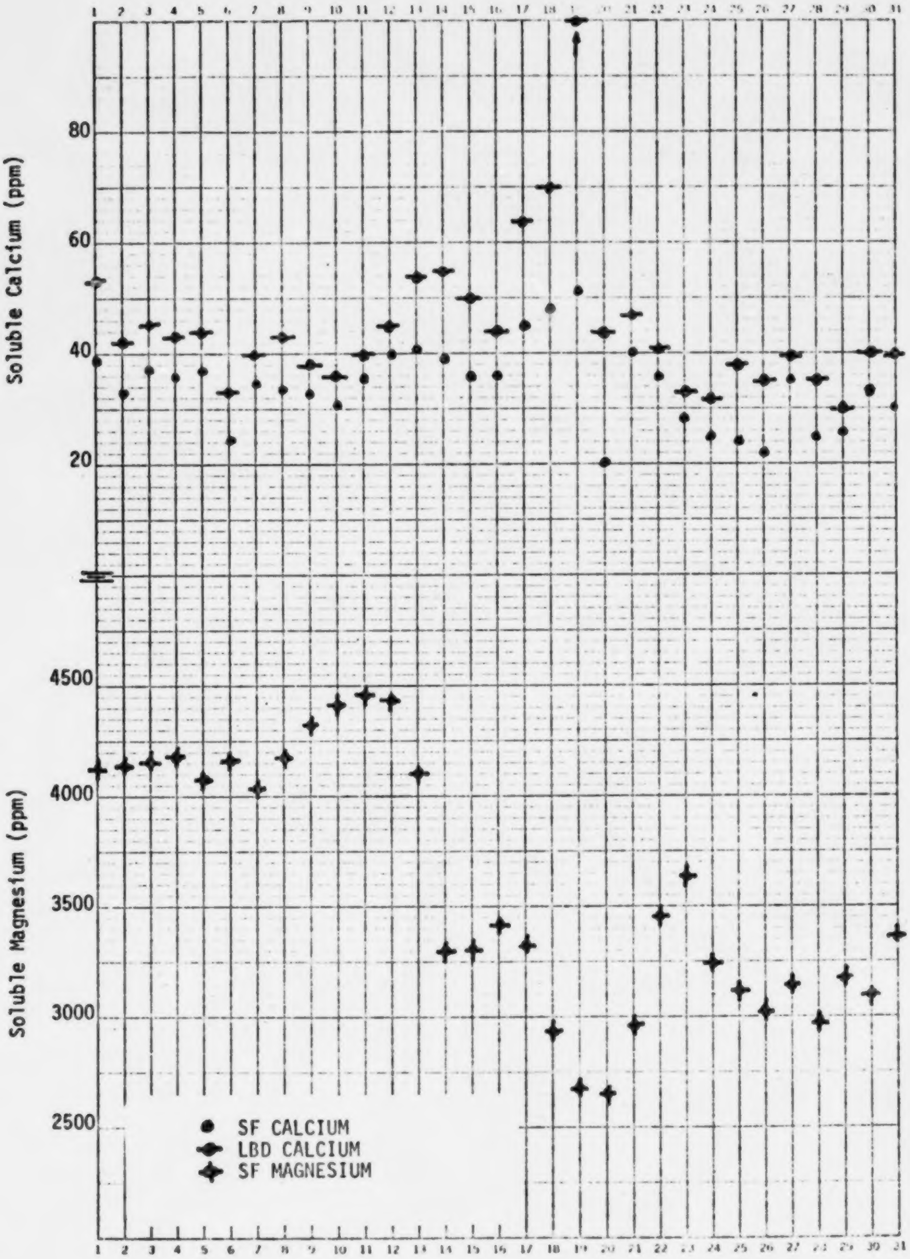

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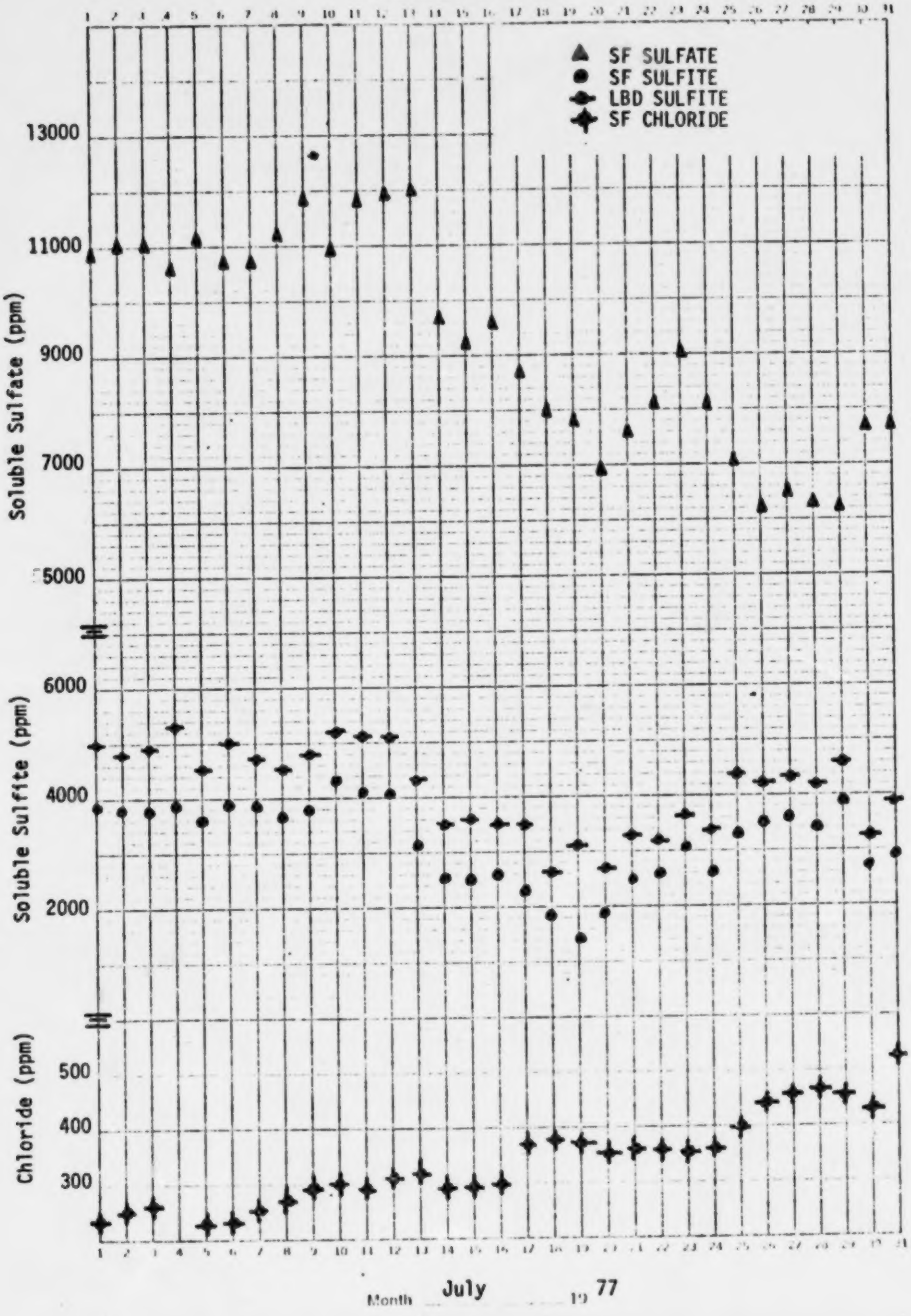

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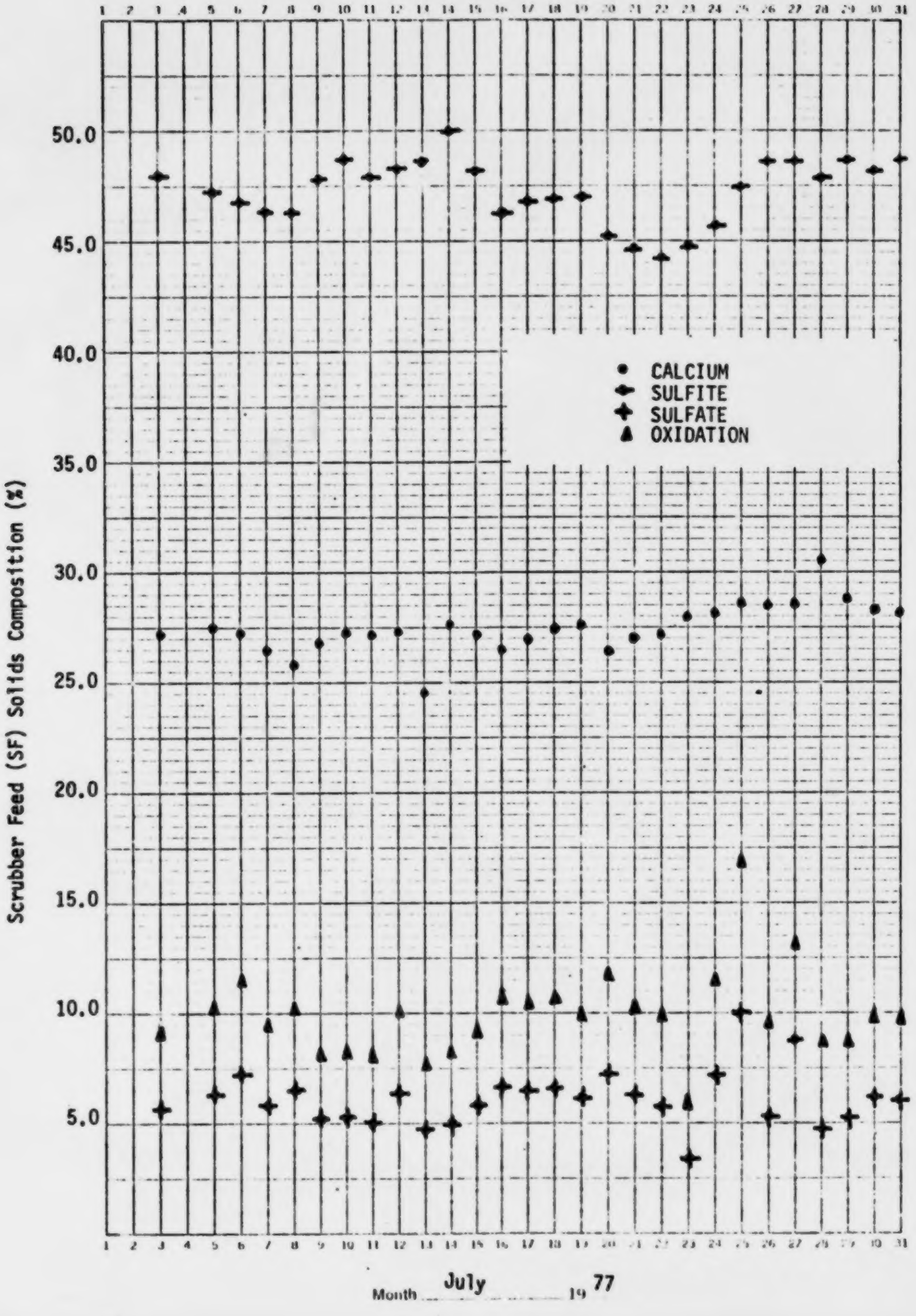

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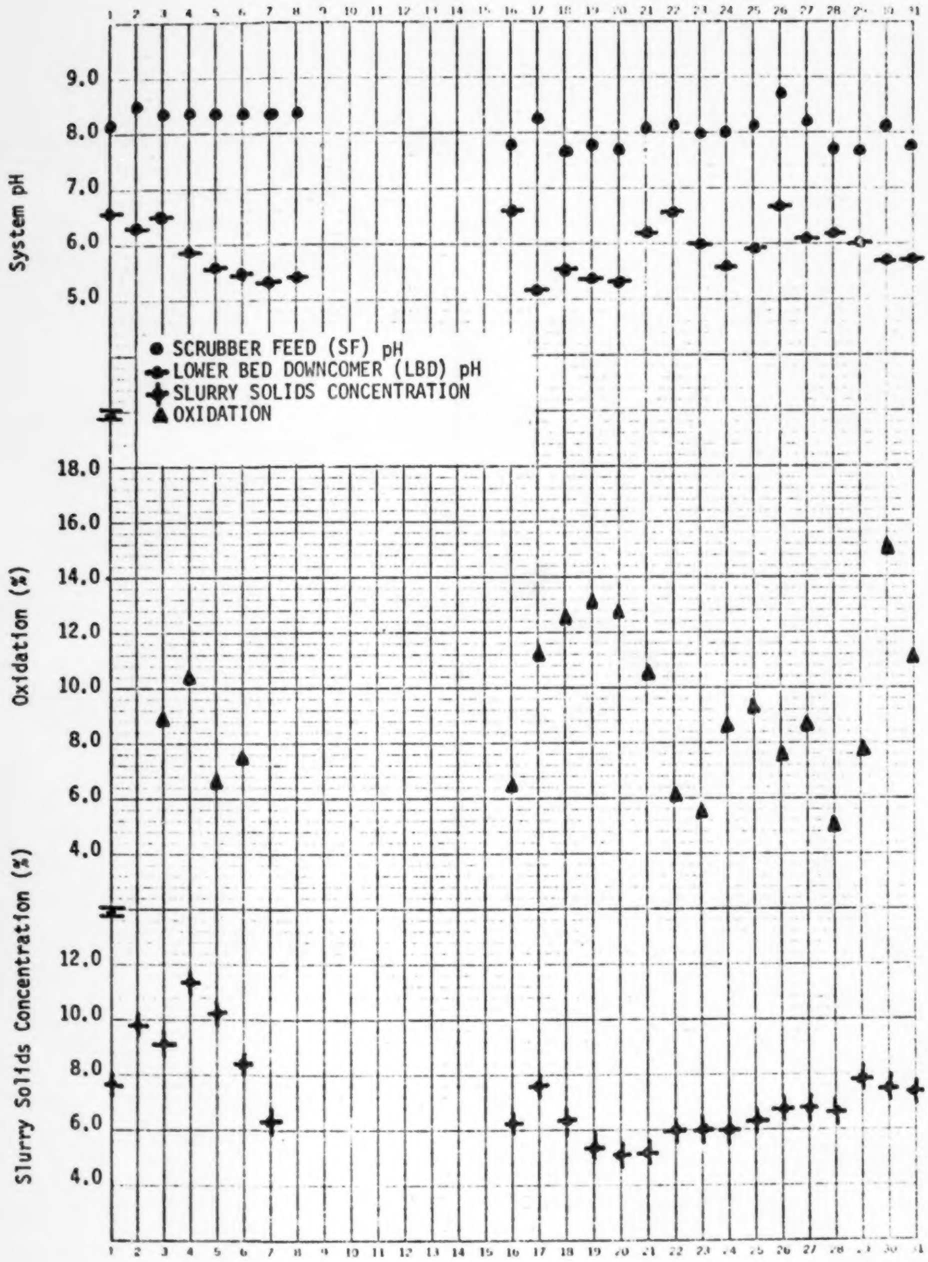

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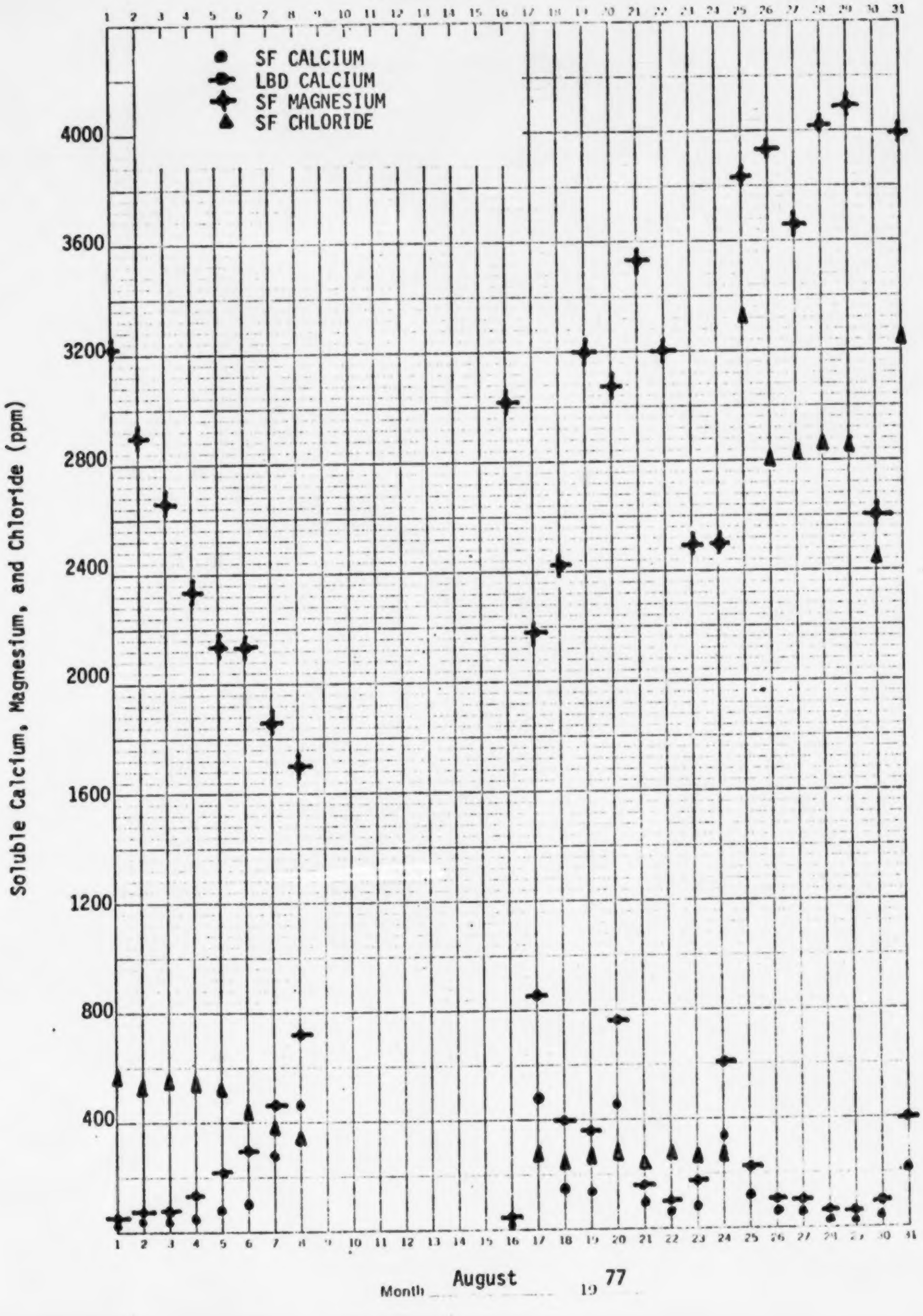

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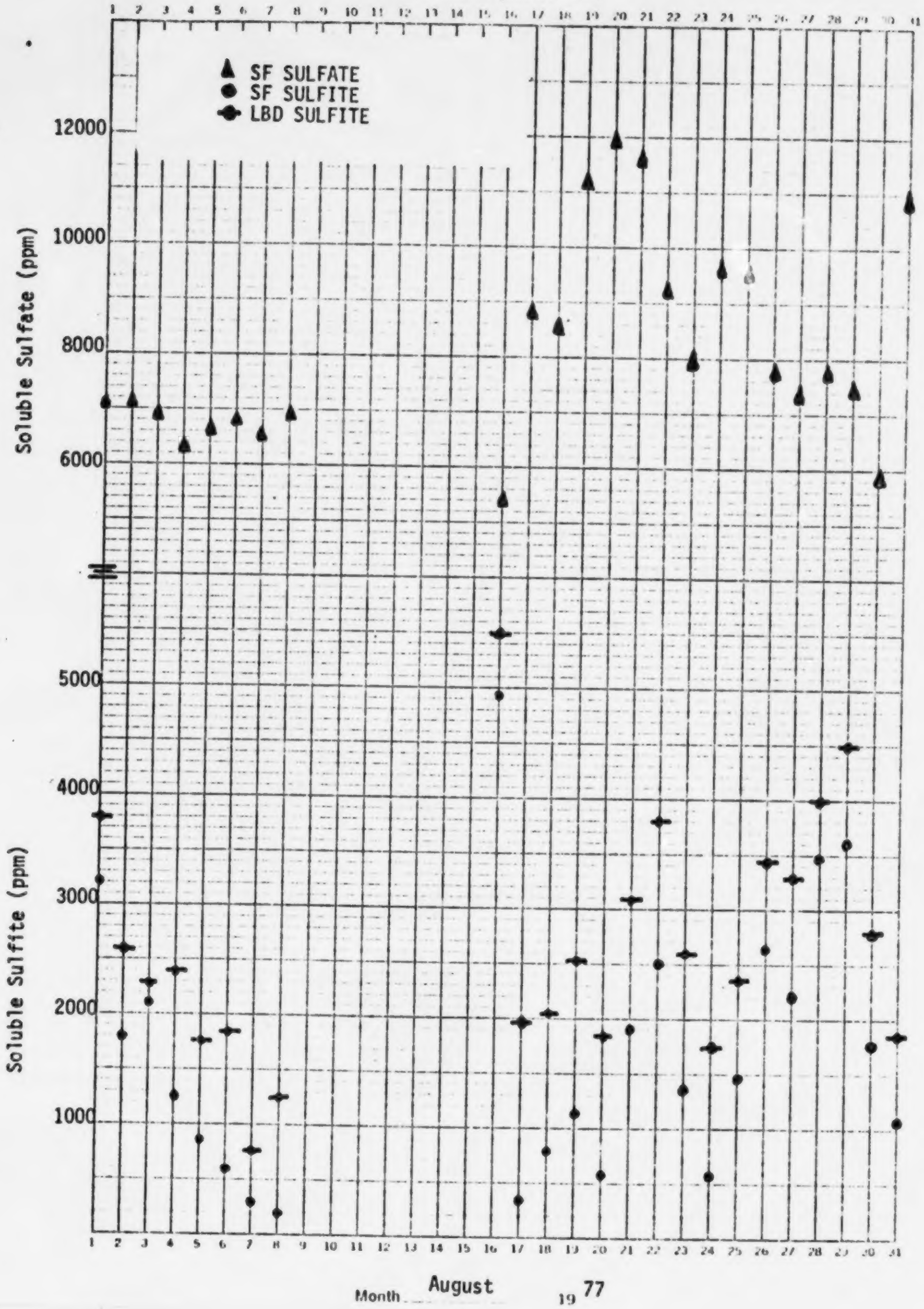

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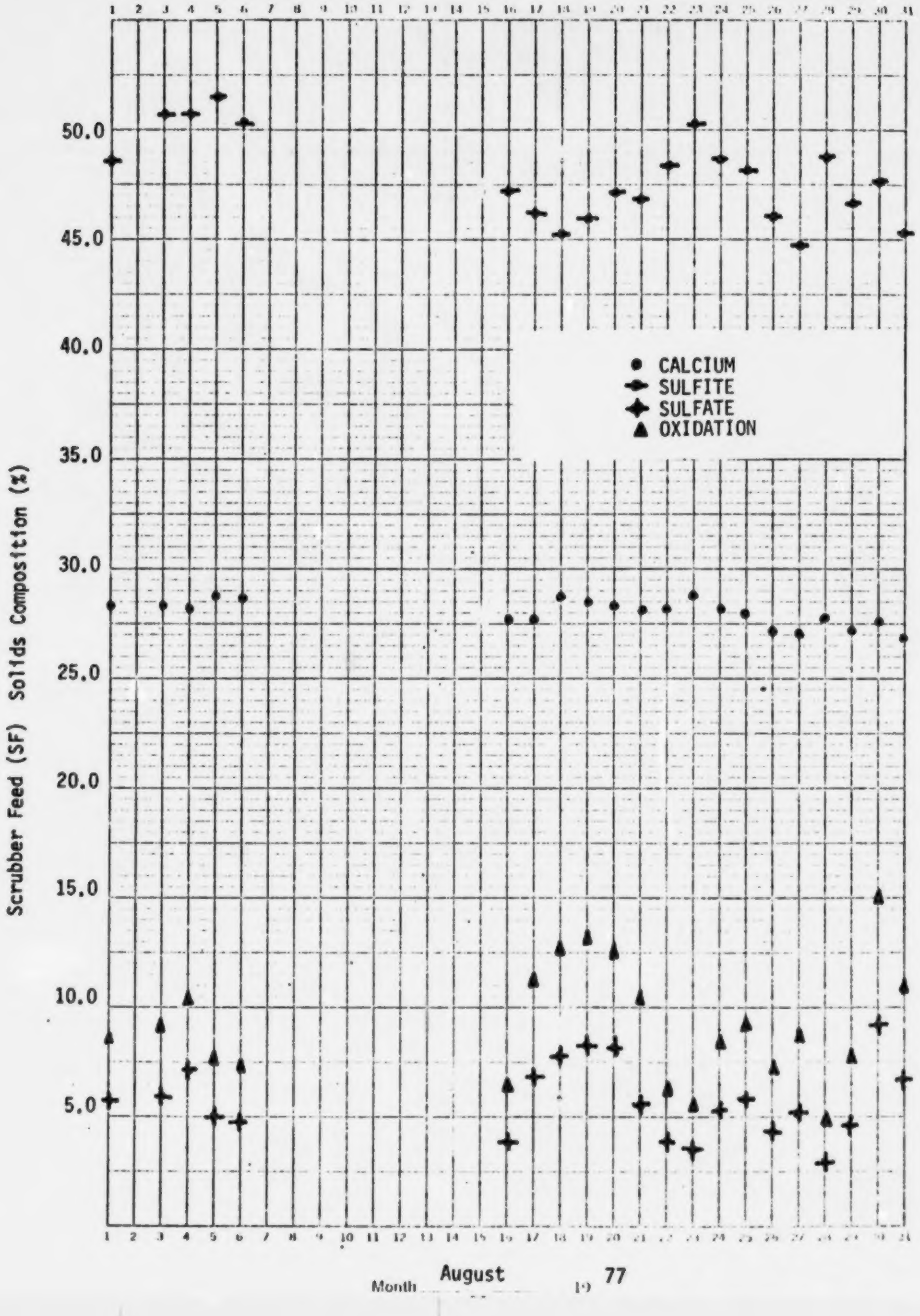

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Table D-1

CHEMICAL DATA SUMMARY

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Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^-	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
Base Commercial Lime Experiment (3/10/77 - 4/14/77)																
3/11/77	1000	201	SF	-	122	7.1	680	250	51	1780	-	28.3	-	42.2	12.1	19.2
		202	LBD	-	122	4.6	1080	370	1470	-	-	-	-	-	-	-
3/12/77	0900	203	SF	.057	124	6.9	680	110	52	1930	200	26.2	0.1	39.0	14.5	23.7
		204	LBD	-	125	4.6	1210	110	1810	2170	-	-	-	-	-	-
3/13/77	0900	205	SF	.062	119	8.3	680	110	43	1990	-	27.4	0.1	42.2	10.8	17.6
		206	LBD	-	122	4.7	1130	120	1410	2460	-	-	-	-	-	-
3/14/77	1030	207	SF	.064	123	8.6	660	130	40	1940	290	28.5	0.1	42.8	12.4	19.4
		208	LBD	-	124	4.7	1180	140	1880	2170	-	-	-	-	-	-
3/14/77	1800	209	SF	.065	120	8.4	640	140	43	1950	-	28.4	0.1	43.9	10.8	17.0
		210	LBD	-	121	4.6	1170	130	1890	2130	-	-	-	-	-	-
3/15/77	0945	211	SF	.082	122	8.7	650	150	38	1990	320	28.7	0.1	43.9	12.0	18.6
		212	LBD	-	124	4.7	1160	150	1810	2180	-	-	-	-	-	-
3/15/77	1700	213	SF	.090	121	8.5	650	160	43	2010	-	28.7	0.1	41.2	15.3	23.6
		214	LBD	-	122	4.7	1100	160	1660	2030	-	-	-	-	-	-
3/15/77	2200	215	SF	.093	123	8.3	640	160	58	1990	-	28.7	0.1	45.0	10.4	16.1
		216	LBD	-	121	4.7	1070	170	1560	2250	-	-	-	-	-	-
3/16/77	1900	217	SF	.094	119	8.4	650	160	36	1920	-	28.7	0.1	44.4	11.6	17.9
		218	LBD	-	120	4.7	1090	160	1500	2170	-	-	-	-	-	-

SF = Scrubber Feed

LBD = Lower Bed Downcomer

Table D-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
3/17/77	1000	219	SF	.113	122	8.4	650	180	38	1990	380	28.3	0.1	44.8	10.8	16.7
		220	LBD	-	125	4.8	1050	187	1450	2240	-	-	-	-	-	-
3/17/77	1700	221	SF	.128	120	8.6	660	180	60	1950	-	28.7	0.1	45.4	9.6	15.0
		222	LBD	-	121	4.7	1040	200	1490	2165	-	-	-	-	-	-
3/18/77	1700	223	SF	.124	118	8.2	660	210	40	1990	-	29.1	0.1	45.6	9.5	14.8
		224	LBD	-	121	4.8	1050	190	1430	2180	-	-	-	-	-	-
3/19/77	0910	225	SF	.123	124	8.4	660	210	43	2030	427	29.3	0.1	45.6	10.5	16.1
		226	LBD	-	125	4.8	1060	220	1570	2120	-	-	-	-	-	-
3/20/77	0800	227	SF	.123	119	8.2	650	210	47	2040	-	29.1	0.1	47.0	7.5	11.8
		228	LBD	-	121	4.7	1080	230	1720	2140	-	-	-	-	-	-
3/21/77	0915	230	SF	.114	118	7.6	640	210	44	2050	380	29.4	0.1	46.7	9.4	14.4
		231	LBD	-	124	4.7	1110	190	1750	2190	-	-	-	-	-	-
3/30/77	1700	233	SF	.115	116	8.2	640	190	70	1230	-	29.7	0.1	46.0	11.4	17.1
		234	LBD	-	118	4.6	1090	210	1680	2270	-	-	-	-	-	-
3/31/77	1330	235	SF	.106	106	8.7	650	73	63	2027	-	29.2	-	46.2	12.6	18.5
		236	LBD	-	114	4.8	1080	180	1700	2250	-	-	-	-	-	-
3/31/77	1900	237	SF	.108	116	8.9	650	180	36	2000	-	29.6	-	46.2	12.6	18.5
		238	LBD	-	116	4.7	1040	170	1420	2380	-	-	-	-	-	-

Table D-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
4/1/77	1400	239	SF	.106	112	8.8	650	180	55	1860	290	25.6	-	46.4	9.5	14.6
		240	LBD	-	116	4.6	1090	180	1720	1990	-	-	-	-	-	-
4/1/77	2100	241	SF	.085	106	8.8	640	120	34	1780	-	26.0	-	45.6	11.3	17.1
		242	LBD	-	114	4.8	1020	130	1330	2170	-	-	-	-	-	-
4/2/77	0800	243	SF	.081	117	8.6	640	120	38	1660	180	31.8	-	46.5	9.3	14.2
		244	LBD	-	118	4.7	1050	130	1480	1910	-	-	-	-	-	-
4/3/77	1030	245	SF	.078	118	8.3	680	100	41	1760	155	29.7	-	47.0	8.8	13.5
		246	LBD	-	119	4.8	1080	110	1390	1830	-	-	-	-	-	-
4/4/77	0930	247	SF	.076	116	8.8	660	90	36	1660	140	29.7	-	48.9	8.1	12.6
		248	LBD	-	118	4.7	1060	110	1500	1800	-	-	-	-	-	-
4/4/77	1900	249	SF	.073	118	8.7	660	87	38	1560	-	30.2	-	46.7	8.6	13.3
		250	LBD	-	120	4.7	1040	97	1120	2200	-	-	-	-	-	-
4/5/77	1000	251	SF	.077	114	8.7	660	130	34	1720	180	29.7	-	46.8	8.8	13.7
		252	LBD	-	119	4.7	1100	130	1520	2006	-	-	-	-	-	-
4/5/77	1700	253	SF	.074	116	8.3	660	130	42	1290	-	29.2	-	45.5	9.5	14.8
		254	LBD	-	118	4.8	950	120	1030	2030	-	-	-	-	-	-
4/5/77	2200	255	SF	.078	118	8.4	670	150	33	1720	-	29.6	-	46.5	9.6	14.7
		256	LBD	-	118	4.8	1050	140	1380	2100	-	-	-	-	-	-

Table D-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^-	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
4/6/77	0830	257	SF	.077	117	8.5	680	160	34	1900	220	29.7	-	46.0	11.7	17.5
		258	LBD	-	121	4.7	1110	180	1530	2040	-	-	-	-	-	-
4/6/77	1800	259	SF	.077	118	8.5	660	160	34	1770	-	-	-	-	-	-
		260	LBD	-	118	4.7	1110	150	1660	1880	-	-	-	-	-	-
4/6/77	2200	261	SF	.082	118	8.6	650	150	22	1790	-	29.4	0.1	46.7	8.9	15.5
		262	LBD	-	117	4.8	1080	160	1480	1920	-	-	-	-	-	-
4/7/77	0830	263	SF	.079	115	8.8	650	170	42	1820	240	28.9	-	46.6	8.8	13.6
		264	LBD	-	120	5.0	1110	180	1640	1980	-	-	-	-	-	-
4/11/77	1700	265	SF	.070	120	8.5	670	200	60	1830	-	28.9	0.2	47.4	9.2	13.9
		266	LBD	-	120	5.1	1140	210	1980	2070	-	-	-	-	-	-
4/11/77	2100	267	SF	.063	119	8.3	670	200	51	1850	-	29.7	0.1	46.8	10.3	15.5
		268	LBD	-	121	4.8	1200	190	1820	1980	-	-	-	-	-	-
4/12/77	0950	269	SF	.068	118	8.5	680	210	37	1880	320	29.5	0.1	46.5	10.0	15.2
		270	LBD	-	122	5.2	1140	220	1660	2040	-	-	-	-	-	-
4/12/77	1700	272	SF	.065	120	8.6	680	210	49	1820	-	29.5	.06	47.5	7.6	11.8
		273	LBD	-	121	5.0	1200	200	1710	2010	-	-	-	-	-	-
4/13/77	1700	282	SF	.061	119	8.6	680	230	46	1910	-	29.7	.06	47.0	10.1	15.2
		283	LBD	-	121	5.0	1180	230	1790	1940	-	-	-	-	-	-
4/14/77	0940	292	SF	.066	119	8.3	690	230	40	1900	360	29.5	0.1	46.7	8.9	13.7
		293	LBD	-	121	5.0	1180	240	1780	2090	-	-	-	-	-	-

Table D-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^-	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
Magnesium Addition Experiments (6/18/77 - 7/25/77)																
6/21/77	1300	300	SF	.042	121	7.8	24	3360	4710	6670	150	28.6	0.87	50.4	4.7	7.2
		301	LBD	-	122	7.0	21	3360	5700	6640	-	-	-	-	-	-
6/21/77	1700	303	SF	.047	124	7.6	17	3120	4280	6970	-	27.4	1.0	51.5	3.7	5.7
		304	LBD	-	120	7.05	26	3170	5160	6560	-	-	-	-	-	-
6/22/77	1030	307	SF	.046	121	7.9	30	2730	2540	6730	150	28.6	0.78	49.8	5.8	8.8
		308	LBD	-	125	6.6	47	2780	3680	6910	-	-	-	-	-	-
6/22/77	1700	310	SF	.046	119	7.5	28	2540	2250	6800	-	28.2	0.83	50.3	4.4	6.8
		311	LBD	-	126	6.5	50	2570	3580	6920	-	-	-	-	-	-
6/23/77	0900		SF	.055	121	7.9	42	2160	1690	6180	160	28.6	0.48	49.5	5.4	8.4
			LBD	-	131	6.1	104	2170	3020	6190	-	-	-	-	-	-
6/23/77	1800	317	SF	.052	121	7.7	46	2050	1280	6490	-	28.8	0.47	49.3	4.9	7.6
		318	LBD	-	126	6.0	150	2100	2680	6490	-	-	-	-	-	-
6/24/77	0900	321	SF	.058	118	8.1	71	2090	1020	6790	170	28.1	0.43	48.3	4.8	7.7
		322	LBD	-	127	5.7	240	2080	2360	6920	-	-	-	-	-	-
6/24/77	1700	324	SF	.049	124	8.0	72	2020	880	6800	-	28.9	0.59	49.9	5.6	8.6
		325	LBD	-	126	6.1	250	2100	2260	7090	-	-	-	-	-	-
6/25/77	0930	328	SF	.053	123	8.1	81	2180	760	7330	184	28.5	0.46	48.5	5.95	9.3
		329	LBD	-	129	5.6	350	2200	2100	7670	-	-	-	-	-	-

Table D-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
6/26/77	0930	331	SF	.051	122	7.9	200	2240	450	8260	-	28.1	0.47	48.1	6.50	10.1
		332	LBD	-	126	5.6	570	2430	2060	8870	-	-	-	-	-	-
6/27/77	0900	334	SF	.054	122	8.0	350	2340	310	9270	190	27.9	0.42	46.7	7.5	11.8
		335	LBD	-	127	5.3	740	2250	1860	9360	-	-	-	-	-	-
6/27/77	1700	337	SF	.047	120	8.0	450	2150	270	9480	-	28.4	0.49	47.0	8.2	12.7
		338	LBD	-	126	5.45	800	2440	1790	10100	-	-	-	-	-	-
6/28/77	0900	341	SF	.051	124	8.05	480	2370	270	9800	190	28.0	0.40	45.7	9.1	14.3
		342	LBD	-	129	5.2	850	2340	1750	9840	-	-	-	-	-	-
6/28/77	1700	344	SF	.049	122	8.1	83	3080	1500	10200	-	27.4	1.66	45.7	7.2	11.6
		345	LBD	-	126	7.8	147	3380	2920	9980	-	-	-	-	-	-
6/29/77	0900	348	SF	.054	122	8.0	79	3030	1420	9910	210	28.0	0.62	47.0	7.4	11.6
		349	LBD	-	127	5.8	190	3060	2890	9870	-	-	-	-	-	-
6/29/77	1730	352	SF	.044	122	7.9	36	3710	3230	10000	-	28.2	0.73	48.3	8.5	12.8
		353	LBD	-	126	6.4	56	3750	4560	9880	-	-	-	-	-	-
6/30/77	0900	356	SF	.047	123	7.5	46	3440	2630	9960	220	28.1	0.69	48.6	6.5	9.9
		357	LBD	-	127	6.15	90	3460	4120	9410	230	-	-	-	-	-
6/30/77	1700	359	SF	.040	124	7.8	33	4200	4500	10500	-	27.5	1.3	49.4	6.2	9.5
		360	LBD	-	126	6.5	41	4210	5360	10700	-	-	-	-	-	-

Table D-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^=$	$SO_4^=$	Cl^-	Ca^{++}	Mg^{++}	$SO_3^=$	$SO_4^=$	Oxidation
7/1/77	0800	363	SF	.040	124	8.0	39	4110	3900	10800	235	-	-	-	-	-
		364	LBD	-	126	6.7	53	4120	5020	10900	-	-	-	-	-	-
7/2/77	0930	366	SF	.040	123	8.1	33	4140	3850	11000	250	-	-	-	-	-
		367	LBD	-	126	6.65	42	4160	4780	11000	-	-	-	-	-	-
7/3/77	0900	368	SF	.040	122	8.1	37	4160	3790	11100	260	27.1	1.2	48.0	5.7	9.0
		369	LBD	-	126	6.6	45	4200	4920	11200	-	-	-	-	-	-
7/4/77	0900	370	SF	.043	123	8.05	36	4190	3990	10600	-	-	-	-	-	-
		371	LBD	-	126	6.65	43	4220	5280	10500	-	-	-	-	-	-
7/5/77	1345	372	SF	.044	124	7.9	37	4080	3620	11200	230	27.5	0.8	47.3	6.4	10.1
		373	LBD	-	128	6.3	44	4060	4520	10900	-	-	-	-	-	-
7/6/77	0845	375	SF	.042	122	7.8	24	4170	3940	10700	230	27.3	1.2	46.8	7.3	11.5
		376	LBD	-	128	6.5	33	4170	5020	10800	-	-	-	-	-	-
7/7/77	0800	380	SF	.045	125	7.7	35	4230	3860	11300	260	27.3	1.1	46.8	5.4	8.8
		381	LBD	-	128	6.6	38	4310	4920	11300	-	-	-	-	-	-
7/7/77	1600	384	SF	.050	126	7.6	36	3850	3980	10200	250	25.7	1.7	46.8	6.1	9.8
		385	LBD	-	128	6.5	40	3760	4420	10900	-	-	-	-	-	-
7/8/77	0700	386	SF	.045	122	8.0	36	4210	3780	11300	270	27.5	1.3	45.9	6.8	11.0
		387	LBD	-	127	7.2	40	4330	4700	11400	-	-	-	-	-	-

Table D-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
7/8/77	1600	389	SF	.045	124	7.9	32	4150	3740	11100	280	26.3	1.4	47.0	6.2	9.4
		390	LBD	-	126	6.65	46	4210	4260	10400	-	-	-	-	-	-
7/9/77	0930	393	SF	.048	121	8.0	33	4330	3820	11900	290	26.8	1.5	47.9	5.1	8.1
		394	LBD	-	127	6.7	38	4340	4780	11500	-	-	-	-	-	-
7/10/77	0830	397	SF	0.05	124	7.8	31	4420	4380	10900	300	27.3	1.3	48.7	5.2	8.2
		398	LBD	-	128	6.6	36	4290	5240	11700	-	-	-	-	-	-
7/11/77	0800	400	SF	.042	122	7.9	36	4460	4060	11800	290	27.1	1.4	47.8	5.0	8.0
		401	LBD	-	127	6.8	39	4500	5080	11800	-	-	-	-	-	-
7/12/77	0800	407	SF	.055	122	7.6	36	4510	4110	12200	310	27.4	1.2	47.2	5.5	8.9
		408	LBD	-	128	6.4	41	4540	5140	12000	-	-	-	-	-	-
7/12/77	1500	410	SF	.062	123	7.5	44	4360	3600	11700	-	27.3	0.96	49.6	7.5	11.1
		411	LBD	-	128	6.3	52	3920	4080	9940	-	-	-	-	-	-
7/13/77	0800	415	SF	.075	123	7.9	39	4200	3080	11900	310	-	-	-	-	-
		416	LBD	-	131	6.3	52	4110	4340	11900	-	-	-	-	-	-
7/13/77	1600	418	SF	.085	122	7.9	44	4000	2870	12100	330	24.5	0.8	48.6	4.7	7.5
		419	LBD	-	128	-	56	4020	3740	12300	-	-	-	-	-	-
7/14/77	0730	422	SF	-	125	7.5	30	3450	2540	9990	280	27.8	0.9	50.5	4.0	7.2
		423	LBD	-	128	6.2	48	3400	3460	9890	-	-	-	-	-	-

Table D-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
7/14/77	1600	427	SF	.082	126	7.9	48	3150	2080	9440	290	27.3	0.9	49.4	6.0	9.2
		428	LBD	-	132	6.3	60	3120	2690	9370	-	-	-	-	-	-
7/15/77	0730	431	SF	.081	122	8.2	32	3330	2520	9030	280	27.1	1.0	49.2	4.0	6.3
		432	LBD	-	127	6.2	48	3230	3640	8740	-	-	-	-	-	-
7/15/77	1600	435	SF	.075	122	8.0	44	3280	2090	9500	310	-	-	47.1	7.9	12.3
		436	LBD	-	130	6.2	53	3190	2300	8630	-	-	-	-	-	-
7/16/77	0830	438	SF	.082	122	7.7	36	3420	2630	9640	300	26.5	1.0	46.2	6.7	10.8
		439	LBD	-	128	6.1	44	3440	3560	9700	-	-	-	-	-	-
7/17/77	0830	441	SF	.088	121	8.0	45	3310	2320	8690	370	27.0	0.9	46.8	6.5	10.4
		442	LBD	-	127	6.3	64	3170	3500	8830	-	-	-	-	-	-
7/18/77	0730	445	SF	.086	122	7.5	38	2970	2000	8330	380	27.9	0.7	47.1	5.9	9.5
		446	LBD	-	128	6.05	69	2940	3190	8470	-	-	-	-	-	-
7/18/77	1700	450	SF	.085	126	8.2	57	2890	1540	7660	-	27.0	0.9	46.5	7.3	11.6
		451	LBD	-	130	6.6	72	2710	2080	7850	-	-	-	-	-	-
7/19/77	0800	453	SF	.080	119	8.4	51	2680	1360	7790	370	27.7	0.9	47.0	6.1	9.8
		454	LBD	-	131	5.3	280	2260	3150	6730	-	-	-	-	-	-
7/20/77	1700	453	SF	.060	121	8.5	20	2650	1940	6960	350	26.4	1.8	45.1	7.2	11.7
		464	LBD	-	122	7.6	44	2880	2650	7550	-	-	-	-	-	-

Table D-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
7/21/77	0800	468	SF	.060	123	8.4	44	2930	2290	7610	360	27.1	1.2	45.1	5.2	8.8
		469	LBD	-	128	6.8	53	2820	2830	7090	-	-	-	-	-	-
7/21/77	1600	471	SF	.059	124	8.5	36	3000	2560	7580	-	26.8	1.1	44.1	7.4	12.3
		472	LBD	-	128	6.8	41	3120	3530	7700	-	-	-	-	-	-
7/22/77	0730	477	SF	.059	121	8.4	41	3130	2570	7890	360	27.2	1.4	44.3	7.4	12.2
		478	LBD	-	124	7.0	53	3100	3210	7530	-	-	-	-	-	-
7/22/77	1630	482	SF	.054	120	8.4	32	3800	4020	8470	350	27.2	1.5	43.9	4.3	7.5
		483	LBD	-	126	7.3	34	3780	4620	8140	-	-	-	-	-	-
7/23/77	0830	485	SF	.056	122	8.3	28	3630	3120	9040	350	28.0	1.1	44.9	3.3	5.8
		486	LBD	-	127	7.1	33	3250	3640	9040	-	-	-	-	-	-
7/24/77	0900	492	SF	.064	122	8.25	25	3230	2640	8140	360	28.2	1.1	45.6	7.1	11.5
		493	LBD	-	126	6.7	32	3080	3420	7770	-	-	-	-	-	-
7/25/77	0615	495	SF	.066	121	7.6	24	3110	3320	7050	400	28.6	0.8	47.5	10.1	16.9
		496	LBD	-	126	6.2	38	3050	4440	6930	-	-	-	-	-	-

Table D-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
Draft Tube Effect Experiment (7/25/77 - 8/8/77)																
7/26/77	0615	504	SF	.076	118	8.5	16	3190	3580	6440	470	28.0	1.2	48.7	5.8	10.4
		505	LBD	-	125	6.5	33	3280	4360	6840	-	-	-	-	-	-
7/26/77	1515	510	SF	.103	118	8.45	28	2860	3340	6050	420	28.9	0.8	48.6	4.6	8.5
		511	LBD	-	124	6.5	36	2840	4140	5040	-	-	-	-	-	-
7/27/77	0615	514	SF	.076	117	8.5	41	3100	3580	6230	450	28.8	0.9	49.1	8.2	12.2
		515	LBD	-	126	6.6	39	3110	4240	6060	-	-	-	-	-	-
7/27/77	1515	517	SF	.073	120	8.6	32	3210	3700	6980	470	28.5	1.4	48.3	9.5	14.1
		518	LBD	-	125	6.8	38	3200	4400	7040	-	-	-	-	-	-
7/28/77	0630	521	SF	.058	117	8.5	24	3010	3280	5930	440	-	-	-	-	-
		522	LBD	-	124	6.8	36	2980	3920	6070	-	-	-	-	-	-
7/28/77	1515	524	SF	.064	118	8.45	25	2910	3600	6730	490	30.6	0.6	47.9	4.6	8.6
		525	LBD	-	125	7.3	34	3100	4480	6020	-	-	-	-	-	-
7/29/77	0830	527	SF	.058	124	7.9	20	3330	4560	5380	440	28.4	0.9	49.2	4.5	8.2
		528	LBD	-	131	6.7	25	3340	5500	5730	-	-	-	-	-	-
7/29/77	1600	529	SF	.061	120	8.2	32	3030	3200	7180	460	29.1	1.1	48.4	5.7	8.9
		530	LBD	-	125	6.8	36	3010	3740	6820	-	-	-	-	-	-
7/30/77	0830	532	SF	.056	120	8.2	33	3100	2720	7740	430	28.4	0.7	48.3	6.3	9.8
		533	LBD	-	127	6.9	40	3120	3220	7830	-	-	-	-	-	-

Table D-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
7/31/77	1230	537	SF	.066	120	8.35	30	3370	2940	7740	530	28.1	1.1	48.8	6.0	9.3
		538	LBD	-	125	6.8	40	3380	3900	6930	-	-	-	-	-	-
8/1/77	0715	541	SF	.077	120	8.2	33	3220	3180	7110	570	-	-	-	-	-
		542	LBD	-	125	6.6	40	3110	3780	7580	-	-	-	-	-	-
8/2/77	0630	552	SF	.098	120	8.4	40	2900	1800	7140	520	-	-	-	-	-
		553	LBD	-	123	6.4	63	2550	2580	6830	-	-	-	-	-	-
8/2/77	1600	557	SF	.098	120	8.6	63	2650	1600	7600	510	-	-	-	-	-
		558	LBD	-	123	6.2	85	2400	2120	7090	-	-	-	-	-	-
8/3/77	0830	559	SF	.082	120	8.4	40	2760	2020	6950	530	28.6	0.6	51.0	5.8	8.7
		560	LBD	-	125	6.5	41	2260	2040	6520	-	-	-	-	-	-
8/3/77	1700	562	SF	.108	120	8.4	62	2610	2100	6040	540	28.2	0.6	50.7	6.3	9.4
		563	LBD	-	124	6.05	83	2190	2340	5930	-	-	-	-	-	-
8/4/77	0830	565	SF	.115	120	8.3	53	2380	1300	6320	530	28.1	0.5	51.0	7.1	10.4
		566	LBD	-	126	5.8	130	2310	2440	6500	-	-	-	-	-	-
8/4/77	1800	568	SF	.111	122	8.5	63	2340	1200	7030	530	28.1	0.4	50.8	7.1	10.4
		569	LBD	-	125	5.9	130	2290	2400	4830	-	-	-	-	-	-
8/5/77	0830	571	SF	.102	120	8.4	76	2130	840	6570	500	28.6	0.5	52.2	4.3	6.4
		572	LBD	-	125	5.6	210	2020	1760	6270	-	-	-	-	-	-

Table D-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
8/6/77	0800	577	SF	.084	122	8.4	87	2140	600	6810	430	28.7	0.3	50.4	4.8	7.4
		578	LBD	-	126	5.5	290	2060	1880	6410	-	-	-	-	-	-
8/7/77	0800	580	SF	.067	120	8.3	280	1850	300	6260	380	-	-	-	-	-
		581	LBD	-	128	5.4	460	1840	740	5840	-	-	-	-	-	-
8/8/77	0900	583	SF	.059	123	8.4	460	1710	200	6910	340	-	-	-	-	-
		584	LBD	-	127	5.3	720	1680	1260	7580	-	-	-	-	-	-
8/8/77	1230	585	SF	-	123	8.4	350	2000	340	7300	330	-	-	-	-	-
		586	LBD	-	125	5.4	600	2030	1590	7370	-	-	-	-	-	-

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Table D-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
Hold Tank Modification Experiment (8/16/77 - 8/24/77)																
8/16/77	1815	592	SF	.061	127	7.8	16	3030	4970	5430	-	27.7	0.7	47.2	3.9	6.4
		693	LBD	-	128	6.6	25	2910	5450	5630	-	-	-	-	-	-
8/17/77	0900	595	SF	.075	124	8.3	480	2170	306	8820	290	27.7	0.4	46.2	6.9	11.1
		596	LBD	-	128	5.2	860	2170	1980	8920	-	-	-	-	-	-
8/17/77	1500	597	SF	-	125	7.9	64	2960	2120	8720	290	-	-	-	-	-
		598	LBD	-	126	6.2	110	2920	3180	8690	-	-	-	-	-	-
8/18/77	0900	601	SF	.063	119	7.6	150	2430	800	8510	230	28.8	0.5	48.7	5.8	9.0
		602	LBD	-	128	5.5	400	2460	2020	8830	-	-	-	-	-	-
8/18/77	1500	604	SF	-	125	7.8	120	2790	1200	9480	2400	-	-	-	-	-
		605	LBD	-	126	5.6	330	2800	2320	9750	-	-	-	-	-	-
8/18/77	1900	606	SF	.059	122	7.0	110	3060	1270	10400	240	28.9	0.2	41.6	9.8	16.4
		607	LBD	-	124	5.7	250	3150	2590	10800	-	-	-	-	-	-
8/19/77	0800	608	SF	.056	123	7.9	140	3200	1110	11200	260	28.5	0.2	44.9	8.9	14.2
		609	LBD	-	126	5.4	360	3210	2510	11100	-	-	-	-	-	-
8/19/77	1600	610	SF	.052	123	7.7	480	2950	570	11700	260	28.4	0.4	47.1	7.7	12.0
		611	LBD	-	126	5.3	790	2950	1920	11800	-	-	-	-	-	-
8/19/77	2130	612	SF	-	123	7.7	500	2930	510	12100	260	-	-	-	-	-
		613	LBD	-	124	5.3	810	2930	1830	12200	-	-	-	-	-	-

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Table D-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^-	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
8/20/77	0900	614	SF	.052	127	7.7	460	3080	580	12000	270	28.4	0.5	45.9	9.3	14.4
		615	LBD	-	128	5.3	770	3030	1860	12200	-	-	-	-	-	-
8/20/77	1430	616	SF	-	122	8.0	220	3390	930	12300	270	28.4	0.5	48.3	6.9	10.6
		617	LBD	-	123	5.9	370	3390	2000	12500	-	-	-	-	-	-
8/21/77	0900	618	SF	.053	125	8.1	88	3560	1900	11600	240	28.1	0.5	46.9	5.5	10.4
		619	LBD	-	126	6.2	160	3560	3060	11700	-	-	-	-	-	-
8/22/77	0900	620	SF	.061	126	8.2	57	3240	2520	9170	280	28.0	0.6	48.1	4.1	6.6
		621	LBD	-	128	6.7	74	3290	3840	9260	-	-	-	-	-	-
8/22/77	1530	622	SF	-	123	8.1	51	3320	2810	9390	300	-	-	-	-	-
		623	LBD	-	124	6.6	73	3330	4270	8760	-	-	-	-	-	-
8/22/77	1900	624	SF	.060	124	8.15	67	2850	1910	8700	270	28.2	0.6	48.8	3.4	5.5
		625	LBD	-	124	6.25	120	2860	3160	8580	-	-	-	-	-	-
8/23/77	0930	626	SF	.057	125	8.0	82	2470	1350	7900	270	28.8	0.5	50.4	3.5	5.5
		627	LBD	-	127	6.0	190	2470	2600	7970	-	-	-	-	-	-
8/23/77	1500	628	SF	-	124	8.0	49	2790	2190	7900	280	-	-	-	-	-
		629	LBD	-	127	6.4	82	2770	3060	7800	-	-	-	-	-	-
8/23/77	1900	630	SF	.063	122	8.0	68	2520	1480	7800	280	28.3	0.4	47.9	2.8	4.7
		631	LBD	-	124	6.1	160	2460	2440	7720	-	-	-	-	-	-
8/24/77	0900	632	SF	.059	122	8.0	340	2500	560	9560	290	28.3	0.4	48.6	5.4	8.5
		633	LBD	-	127	5.6	620	2490	1750	9790	-	-	-	-	-	-

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Table D-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	$Ca^{\ddagger}$	$Mg^{\ddagger}$	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	$Ca^{\ddagger}$	$Mg^{\ddagger}$	$SO_3^{=}$	$SO_4^{=}$	Oxidation
Chloride Addition Experiments (8/24/77 - 8/30/77)																
8/24/77	1630	634	SF	.061	123	8.45	1190	3730	330	5740	8890	28.2	0.1	41.6	11.0	18.1
		635	LBD	-	127	5.2	1380	3720	1430	5040	-	-	-	-	-	-
8/24/77	2100	636	SF	-	122	8.3	960	4010	490	8750	6380	-	-	-	-	-
		637	LBD	-	125	5.4	1110	4010	1700	8580	-	-	-	-	-	-
8/25/77	0900	638	SF	.071	121	8.1	120	3860	1470	9450	3330	28.4	0.6	48.7	5.7	8.8
		639	LBD	-	126	5.9	210	3900	2390	9580	3310	-	-	-	-	-
8/25/77	2000	640	SF	.057	121	7.6	40	4310	3430	8220	2320	27.6	0.8	46.5	5.9	9.6
		641	LBD	-	123	6.6	65	4140	4030	8950	-	-	-	-	-	-
8/26/77	0900	642	SF	.068	126	8.2	68	3910	2240	8450	3500	28.2	0.7	47.5	4.9	8.0
		643	LBD	-	127	6.2	87	3870	3060	8570	-	-	-	-	-	-
8/26/77	1430	644	SF	.068	126	8.7	57	3820	2630	7760	2850	-	-	-	-	-
		645	LBD	-	128	6.7	66	3840	3410	7940	-	-	-	-	-	-
8/26/77	1930	646	SF	.072	122	8.2	120	3220	1090	7990	2820	26.2	0.5	44.3	3.6	6.4
		647	LBD	-	128	5.7	230	3150	2120	7930	-	-	-	-	-	-
8/27/77	0900	648	SF	.068	127	8.2	61	3650	2200	7320	2840	27.0	0.6	44.8	5.1	8.6
		649	LBD	-	128	6.1	87	3630	3300	7800	-	-	-	-	-	-
8/28/77	0630	650	SF	.066	124	7.65	36	4030	3480	7760	2880	27.8	0.9	48.9	2.9	4.8
		651	LBD	-	129	6.2	55	4120	4030	7480	-	-	-	-	-	-

Table D-1

CHEMICAL DATA SUMMARY

Sample Identification				Slurry Properties			Liquid Phase (PPM)					Solid Phase (%)				
Date	Time	No.	Stream	Solids Fraction	Temp. (°F)	pH	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Cl^{-}	Ca^{++}	Mg^{++}	$SO_3^{=}$	$SO_4^{=}$	Oxidation
8/29/77	0900	652	SF	.072	127	7.9	38	4100	3650	7510	2940	27.8	0.7	48.2	4.4	7.1
		653	LBD	-	129	6.4	47	4070	4510	7590	-	-	-	-	-	-
8/29/77	1930	654	SF	.087	122	7.6	53	3160	2100	6390	2780	26.5	0.6	45.2	4.8	8.2
		655	LBD	-	126	6.0	87	3130	3060	6620	-	-	-	-	-	-
8/30/77	0900	656	SF	.075	123	7.9	45	2630	1780	5170	2230	27.6	0.5	47.7	9.3	15.0
		657	LBD	-	126	6.0	94	2630	2830	4900	-	-	-	-	-	-
8/30/77	1700	658	SF	.075	124	8.1	330	2120	490	5830	2450	-	-	-	-	-
		659	LBD	-	129	5.65	490	2290	1380	5920	-	-	-	-	-	-
8/30/77	2100	660	SF	.070	124	8.05	320	2840	680	7530	2790	-	-	-	-	-
		661	LBD	-	128	5.55	480	2780	1740	7540	-	-	-	-	-	-
8/31/77	0830	662	SF	.074	127	7.8	220	4040	1040	10800	3250	26.8	1.0	45.3	6.7	11.0
		663	LBD	-	129	5.7	410	3990	1850	10500	-	-	-	-	-	-

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Waste Disposal Study
Commercial Lime Test Phase

C-E waste disposal supervision arrived at Paddy's Run on 6/20/77 to check out the waste disposal system in preparation for Phase II operation. All equipment was checked for proper operation, cleaned, lubricated and repaired as required. The fly ash surge hopper and slurry surge tank were emptied and cleaned.

The filter cake, four flite live bottom bin (installed during the outage between Phase I and Phase II) was checked out and calibrated with filter cake made from "commercial" lime slurry. The additive feeder was also calibrated for "quick lime" (CaO) feed. (See Figure D-6)

The fly ash hopper bottom was modified to include installation of an air-blast unit to be used to break up bridged fly ash in the hopper. All check out and calibration of the Phase II waste disposal system was completed by 7/2/77.

Preparation of Test Mixes

Mix #9 (50% solids, 1.5:1 fly ash:sludge, 3% CaO)

Operations scheduled for 6:00 a.m. on 7/6/77 and were begun on 7/7/77 due to authorized unavailability of the contracted truck drivers.

A 30% solids slurry from the thickener underflow was pumped from the Waste Disposal System (WDS) slurry surge tank into the filter press to produce 50% solids filter cake. Fly ash and fixative (CaO) were metered into the mill feed screw just behind the fixed mixing plate while the filter cake was metered into the mill feed screw at the farthest point from the mill. The separated feed points of fly ash and cake were installed to reduce the "hand persuation" of the bridged materials at the former common point of feed of the fly ash and cake.

The first batch of Mix #9 was completed at 12:30 p.m. after the arrival of first truck on site at 11:00 a.m. Four batches were completed through the mixer by 1:40 p.m. when the live bottom bin drive belt broke. Mixing operations discontinued. A replacement belt was located, obtained and installed by 9:30 a.m. on 7/8/77. A second truck then arrived on site and filling of pond #5 was initiated. (See Figure D-7)

Nine batches of Mix #9 completed by 2:30 p.m. on 7/8/77 due to buildup of cake on the inside of the mill housing. An impact vibrator was installed in the ash hopper to try and improve operations. Many air blasts were required to keep fly ash running. As a result of fly ash level in fly ash surge hopper, only 7 additional batches were completed by 11:00 p.m.

Transfer of additional fly ash were required to fill the surge hopper, however, station personnel could not get fly ash transferred to the fly ash surge hopper until 8:30 a.m. on 7/9/77.

Mixing resumed at 9:00 a.m. but the Bauer mill kept tripping out due to high mill amps. upper examination of the mill was found to be plugged with solids. The solids were cleaned from mill, and after reassembly the mill was returned to service at about 5:30 p.m. Mixing operations were shut down at 9:00 p.m. over Sunday.

It was suggested that mill feed screw-bridging problems could be eased by feeding the fly ash into the Bauer mill through the hollow shaft of the mill feed screw. C-E windsor contracted to see what could be obtained.

Mix #9 operations were completed at 2:15 p.m. on 7/11/77 and completed filling of swimming pool #5 at Lone Run station.

Mix #8 (50% solids, 0.5:1 fly ash, 3% CaO)

Mix #8 mixing operations were initiated at 2:20 p.m. on 7/11/77 to fill swimming pool #6 and pit #3. Mixing was completed on 7/16/77 in spite of many holdups to mixing operations due to lack of trucks for loading, new trucks with leaking tailgates, waiting for full trucks to be emptied into the swimming pool (no backhoe), etc. Two additional trucks were supplied to get the transfer truck fleet up to four trucks by 7/14/77. The cement vibrator used to keep fly ash flowing into the Bauer mill stopped working on 7/13/77. Two replacement vibrators were rented on 7/15/77.

The fly ash transfer pump which pumps the fly ash from the precipitator hoppers to the main fly ash storage silo broke down on 7/14/77. Fly ash was not available at the mixing station until 9:00 p.m. on 7/15/77.

One worker slipped and fell from the truck to the ground (without serious injury), thus a work platform was planned for installation between the top of slurry surge tank and the support steel for Bauer mill to eliminate this problem.

Mix #11 (50% solids, 1:1 fly ash, 3% CaO)

Mix #11 mixing operations were initiated at 9:00 a.m. on 7/16/77. Swimming pool #7 was filled on 7/19/77 and pit #5 was filled on 7/21/77. The filter press developed filter cloth leak on one plate on 7/20/77. The faulty plate was removed and a replacement gasket and filter cloths were ordered, while operations continued. The work platform was installed on 7/20/77.

The outboard bearing of the 4" fly ash screw conveyor wore out and fell apart. A new bearing was obtained and installed in less than two hours!!

Mix #12 [50% solids, 1:1 fly ash, 3% $Ca(OH)_2$]

Mixing was started at 5:00 p.m. on 7/21/77 after calibrating the fixative feeder for $Ca(OH)_2$ (lydrated lime). One truckload of Mix #12 was dumped into the east end of Pit #5 by mistake due to hoist air cylinder leakage on the dump truck. Mix #12 was used to fill swimming pool #8 on 7/25 and

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Pit #4 on 7/13/77. Pool #8 was overfilled and excess material was removed by backhoe and placed in Pit #4.

Several mechanical difficulties delayed completion of filling Pit #4 from 7/26/77 to 7/31/77. The fly ash surge hopper was found plugged with wet fly ash and had to be emptied and cleaned. The slide gate valve on the fly ash hopper bottom was broken. The inboard bearing of the Bauer mill was worn excessively causing excessive mill vibrations.

Fortuitously, a pneumatic fly ash transporter ordered by C-E Windsor to solve the fly ash feeding problem was delivered on 7/26/77. A decision was made to install the transporter, clean the fly ash tank, repair the 6" slide gate valve and replace the inboard beaming of the mill at this time.

All repairs and modifications were completed by 4:00 p.m. on 7/30/77.

Mix #10 (50% solids, 1:1 fly ash, 3% portland cement)

Mixing operations on Mix #10 started at 1:00 a.m. on 7/31/77 and completed at 1:00 p.m. on 8/1/77 to fill swimming pool #9. The only problem to delay the mixing operations was that the air compressor ran out of fuel, resulting in 3-4 hour delay trying to get it started. The feeding of fly ash into the mill through the hollow sludge feed screw greatly improved the mixing operation and reduced mixing time by more than half. The fixative was metered batchwise directly into the live bottom hopper with each batch of filter cake.

Mix #7 (65% solids, 1:1 fly ash, no fixative)

Mix #7 mixing operations were started at 1:00 p.m. on 8/1/77 and completed at 1:00 p.m. on 8/2/77 to fill swimming pool #10.

Commercial Waste Disposal System

Based on the experience gained during these tests, a schematic of a proposed commercial waste disposal system is shown in Figure D-8. It would consist of a vacuum filter to produce cake which is fed by a belt feeder along with metered fixative into a live bottom hopper. The cake and fixative would feed from the live bottom hopper into the feed screw of the Bauer mill. The fly ash would be fed from a fly ash hopper through a variable speed rotary feeder to meter the fly ash flow rate. The fly ash would then be transported by air from the rotary feeder into the Bauer mill through the hollow shaft of the feed screw.

The mix could then be discharged directly into trucks or onto a conveyor which would transport the desired mixture to the disposal area.

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MODIFICATIONS

1 LIVE BOTTOM BIN ADDED

2 PNEUMATIC CONVEYING SYSTEM ADDED

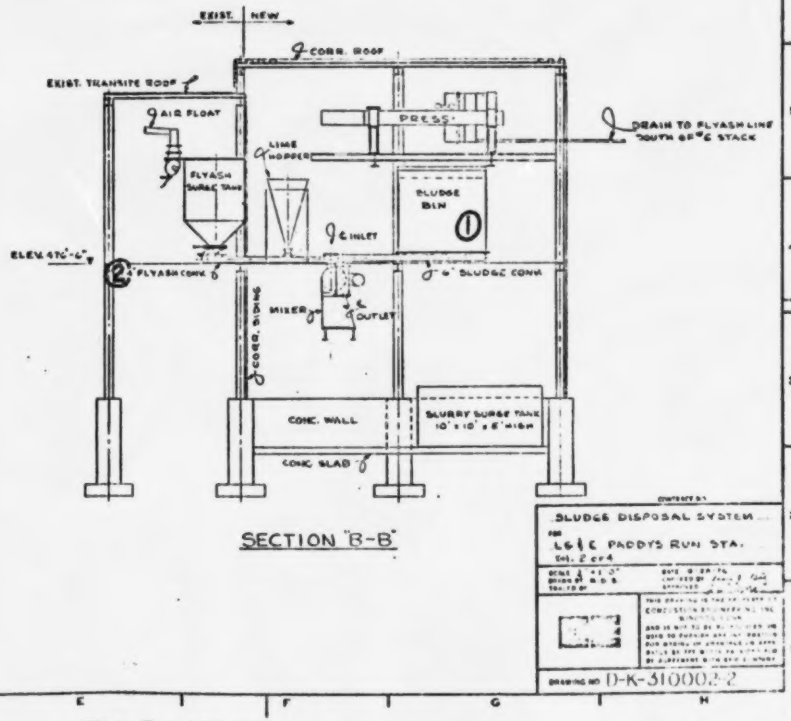
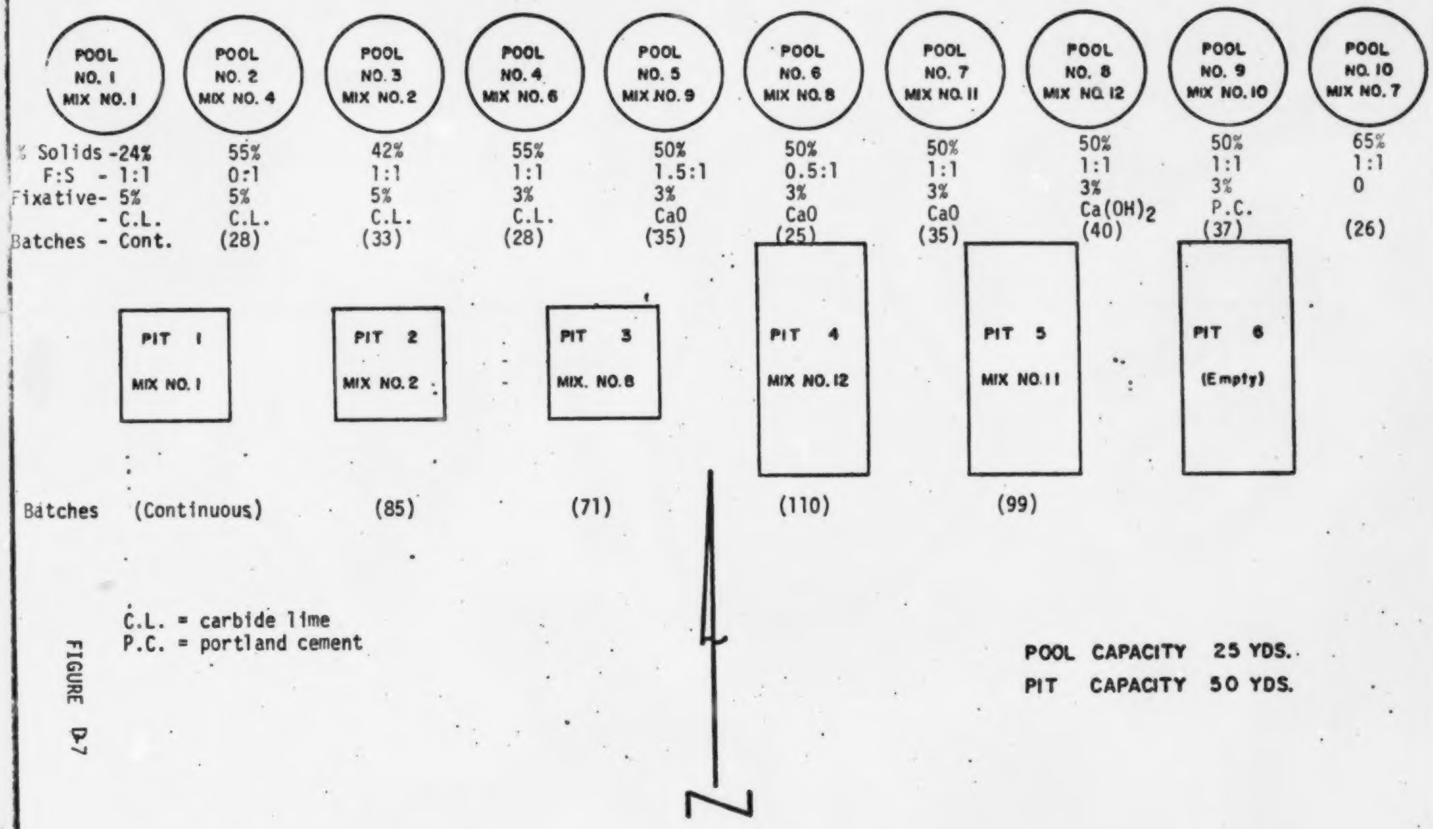

EXIST.
NEW
℄ CORR. ROOF
EXIST. TRANSITE ROOF
℄ AIR FLOAT
PRESS
DRAIN TO FLYASH LINE SOUTH OF #6 STACK
LIME HOPPER
FLYASH SURGE TANK
SLUDGE BIN
①
℄ INLET
ELEV. 476'-6"
②
FLYASH CONV.
6" SLUDGE CONV.
MIXER
℄ OUTLET
℄ CORR. SIDING
CONC. WALL
SLURRY SURGE TANK 10' x 10' x 6' HIGH
CONC. SLAB
SECTION "B-B"
SLUDGE DISPOSAL SYSTEM
FOR
LG & E PADDYS RUN STA.
SH. 2 OF 4
DRAWING NO. D-K-310002-2

FIGURE D-6

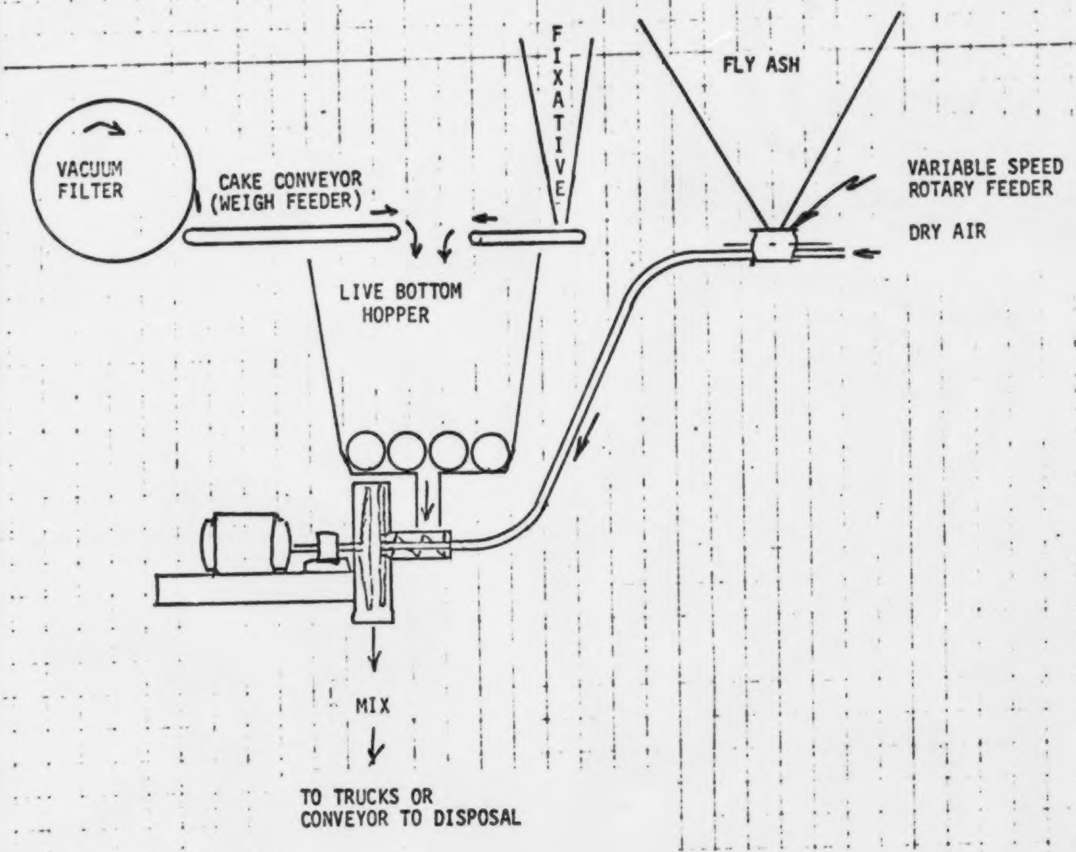
SLUDGE IMPOUNDMENT SITE


POOL NO. 1 MIX NO. 1
POOL NO. 2 MIX NO. 4
POOL NO. 3 MIX NO. 2
POOL NO. 4 MIX NO. 6
POOL NO. 5 MIX NO. 9
POOL NO. 6 MIX NO. 8
POOL NO. 7 MIX NO. 11
POOL NO. 8 MIX NO. 12
POOL NO. 9 MIX NO. 10
POOL NO. 10 MIX NO. 7
% Solids -24% 55% 42% 55% 50% 50% 50% 50% 50% 65%
F:S - 1:1 0:1 1:1 1:1 1.5:1 0.5:1 1:1 1:1 1:1 1:1
Fixative- 5% 5% 5% 3% 3% 3% 3% 3% 3% 0
- C.L. C.L. C.L. C.L. CaO CaO CaO Ca(OH)2 P.C.
Batches - Cont. (28) (33) (28) (35) (25) (35) (40) (37) (26)
PIT 1 MIX NO. 1
PIT 2 MIX NO. 2
PIT 3 MIX. NO. 8
PIT 4 MIX NO. 12
PIT 5 MIX NO. 11
PIT 6 (Empty)
Batches (Continuous) (85) (71) (110) (99)
N

C.L. = carbide lime
P.C. = portland cement

POOL CAPACITY 25 YDS.
PIT CAPACITY 50 YDS.

FIGURE D-7


VACUUM FILTER
CAKE CONVEYOR (WEIGH FEEDER)
FIXATIVE
FLY ASH
VARIABLE SPEED ROTARY FEEDER
DRY AIR
LIVE BOTTOM HOPPER
MIX
TO TRUCKS OR CONVEYOR TO DISPOSAL

SCHEMATIC OF COMMERCIAL WASTE DISPOSAL SYSTEM

FIGURE D-8

TABLE D-2

Summary of Mix Composition Data

Mix #	Average % Solids		Range % Solids		Nominal Mix Composition
	Cake	Mix	Cake	Mix	
7	37 (10)	63 (8)	35-40	58-65	65% Solids Cake 1:1 Fly Ash Ratio 0% Fixative 78.8% Solids in Mix
8	37 (8)	60 (8)	35-40	45-70	50% Solids Cake 0.5:1 Fly Ash Ratio 3% CaO 61% Solids in Mix
9	41 (10)	67 (8)	38-42	66-69	50% Solids Cake 1.5:1 Fly Ash Ratio 3% CaO 72% Solids in Mix
10	37 (6)	66 (10)	35-39	64-68	50% Solids Cake 1:1 Fly Ash Ratio 3% Portland Cement 67% Solids in Mix
11	38 (28)	68 (36)	30-47	55-78	50% Solids Cake 1:1 Fly Ash Ratio 3% CaO 67% Solids in Mix
12	45 (24)	67 (30)	35-47	60-80	50% Solids Cake 1:1 Fly Ash Ratio 3% $Ca(OH)_2$ 67% Solids in Mix

( ) = Number of samples in average.

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APPENDIX E

FIELD TEST RESULTS
STRENGTH AND PERMEABILITY

The work reported in this appendix summarizes results of three basic tasks carried out throughout at least 725 days of the test program.

A) *In-situ* vane shear strength tests performed at the time of placement of the prepared by-product sludge mixtures and periodically throughout the test period. Results are reported as unconfined compressive strengths to allow comparison with similar laboratory tests.

B) Laboratory unconfined compression tests were performed on samples obtained by Shelby tubes at the same time that the *in-situ* vane shear strength tests were performed.

C) Laboratory permeability tests were performed utilizing segments of the Shelby tube core samples obtained for the strength testing.

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EVALUATION OF FIELD IMPOUNDMENTS FOR STRENGTH AND PERMEABILITY

Mix 1 (Pit 1 and Pool 1)

Mix 1 was placed in Pit 1 and was of soupy consistency with a nominal final solids content of 39.3%. Individual batches ranged from 36 to 50% solids. The nominal composition was: 24% carbide lime sludge (thickener underflow), 1:1 fly ash to dry sludge ratio, 5% dry carbide lime fixative.

Strength - Prior to September, 1978, the extremely soft consistency of the mixture in Pit 1 precluded sampling except in February, 1977, (197 days after placement) when the sludge had frozen. On September 28, 1978, (686 days) the investigators obtained continuous core samples and a virtually complete record of field vane shear strength with depth. During summer 1977, a desiccated crust was found in the upper few inches of the pit. When the pit was sampled in September 1978, a crust again was found in the top 30.5 to 40.6cm (12 to 16 inches) of the deposit. A stiff layer was found at 55.9cm (22 inches), but this stiff layer was underlain by softer material.

The results of the 1978 vane shear tests in Pit 1 are shown in Figure E-1, together with results of field vane shear tests performed during 1976 and 1977. Although the nominal solids content of the material in Pit 1 was approximately 39% at the beginning of the testing period, evaporation or loss of supernatant water increased the solids content to between 45 and 55%. In September, 1978, the average solids content of the materials at the sampled depth was about 58%. In the top 20.3 to 30.5cm (8 - 12 inches) of material, the dried-out crust had a solids content of approximately 75%.

The samples secured during the latest sampling operation showed unconfined compressive strengths between 0.012 - 0.0397 MPa (0.125 and 0.415 t/ft^2) with corresponding undrained shear strengths between 0.0057 - .0201 MPa (0.06 and 0.21 t/ft^2). A sample obtained in the dry dessicated crust crumbled when removed from the sampling tube. The strain at failure in these unconfined compression tests varied from 6.5% to 8%, this mixture being more plastic than

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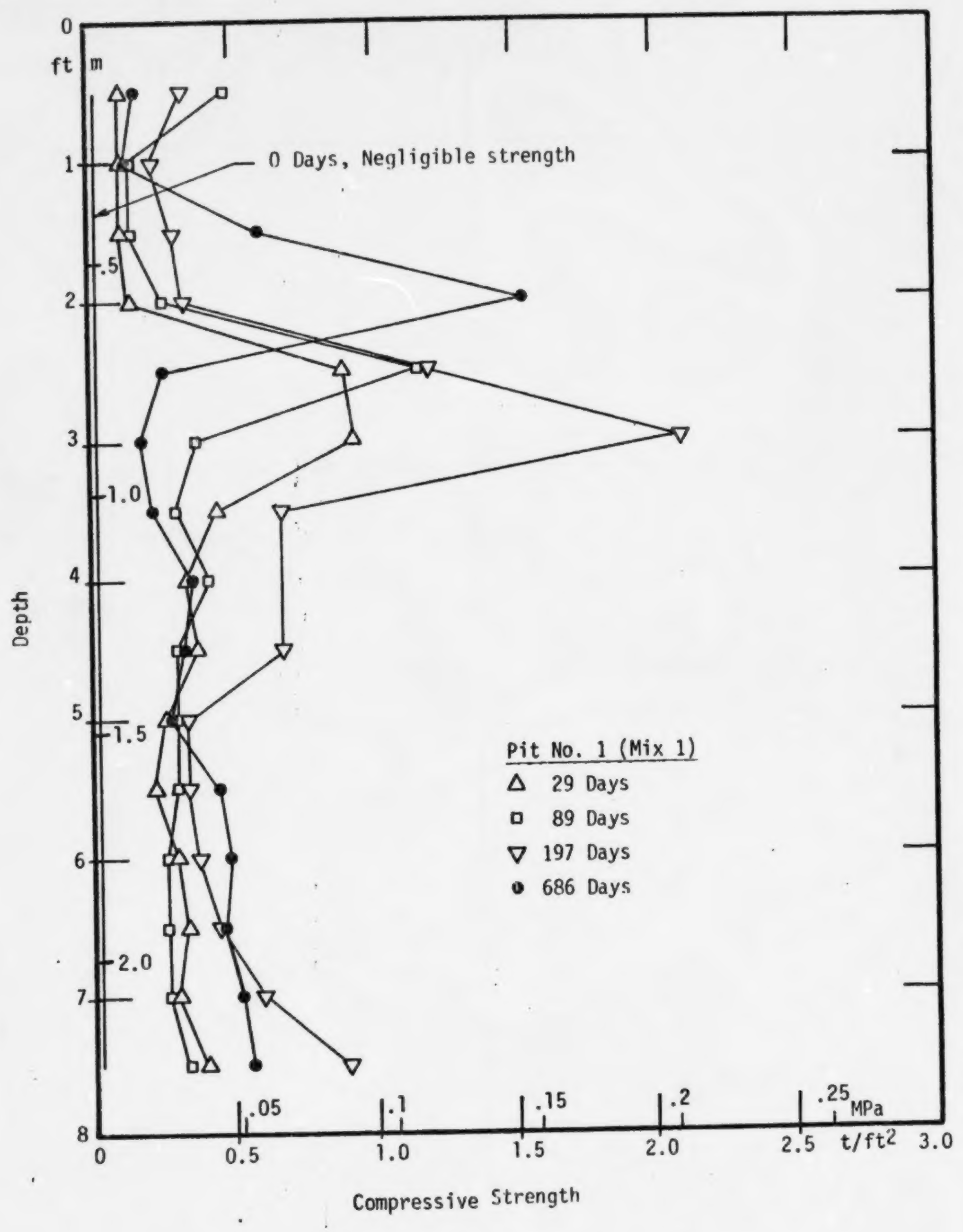

Figure E-1 In-Situ Strength Values for Pit No. 1

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the material in other pits. Laboratory tests on this mix had shown the material too soft for 60-day unconfined compression strength testing. (Table 3 - Section 5)

Permeability - Permeability tests were performed on two samples obtained from Pit 1. The sample obtained from a depth of 15.2 - 30.5cm (6 - 12 in) in the deposit exhibited a permeability coefficient of 2.3×10^{-5} cm/sec at a solids content of approximately 62%, while the sample obtained between 68.6 and 83.8cm (27 and 33 in) below the surface of the deposit showed a coefficient of permeability of 2.9×10^{-5} cm/sec at a solids content of approximately 56%. Permeability tests on this mix conducted prior to field placement had shown a coefficient of permeability of 7.5×10^{-5} cm/sec.

Mix 2 (Pit 2 and Pool 3)

Mix 2 was a fairly moist mixture containing approximately 60% solids in the final mix. Individual batches ranged from 56 to 65% solids. The nominal composition was:

42% carbide lime sludge
1:1 fly ash to dry sludge solids ratio
5% dry carbide lime fixative

Strength - Initial strength tests were run two days after placement. It was noted that the resistance to insertion of the vane shear device varied considerable with depth, down to .9 to 1.2m (3 to 4 feet) indicating layers of different consistency were present. The compressive strength values varied from .029 MPa (0.3 t/ft^2) near the top of the sludge deposit to about .067 MPa (0.7 t/ft^2) near the bottom. Variations in vane shear tests with depth at 38 days (mid-January 1977) indicated layers with compressive strength values from .057 - .287 MPa (0.6 to 3.0 t/ft^2), it is felt that freezing contributed to these variations. Freezing was also apparent in March in the 1 to 4 foot depths; surface thawing had begun to occur causing a decrease in strength from January tests. After complete thawing in June 1977, in-situ tests showed compressive strengths varying with depth from .115 to .287 MPa (1.2 t/ft^2 to $>$3.0 t/ft^2). These test results, unaffected by freezing,

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showed that a true increase in strength had occurred from initial placement. Vane shear tests, the following year in September, showed similar strength values to those measured the previous June. The vane shear tests results for Pit 2 (Mix 2) are shown in Figure E-2, in terms of unconfined compressive strength.

Samples were collected using the Shelby tube sampler at the same time that in-situ vane shear tests were run. The sludge mixture was too soft on the two day tests and could not be retained in the tube sampler, but samples were successfully taken on the later sampling periods. The strength values for samples from Field Mix 2 tested in the University of Louisville laboratory are shown in Figure E-3. In general, these lab strengths are lower than in-situ tests due to disturbance during sampling.

The last strength test results indicated some deterioration of the near-surface layers of the mixure but at depth the strength appears to have increased with time compared to initial values obtained.

Permeability - The results of permeability tests performed on the samples obtained from Pit 2 are shown in Table 6. In general, except for the upper 18 inches of the deposit where weathering has occurred, the permeability of the material in Pit 2 appears to be $<6 \times 10^{-6}$ cm/sec. (Figure E-4)

Mix 4 (Pool 2)

Pool 2 was filled with Mix 4, with a nominal final solids content of 56.3 with individual batches ranging from 56-65% solids.

The nominal composition was:
55% carbide lime sludge
 5% dry carbide lime fixative

Strength - Prior to compaction, the mixture, which had very irregular surface in the pool, was sampled and tested in-situ seven days after placement. The compacted, partially frozen sludge was sampled and tested again 30 days after placement. Samples obtained at this time were tested after they had been

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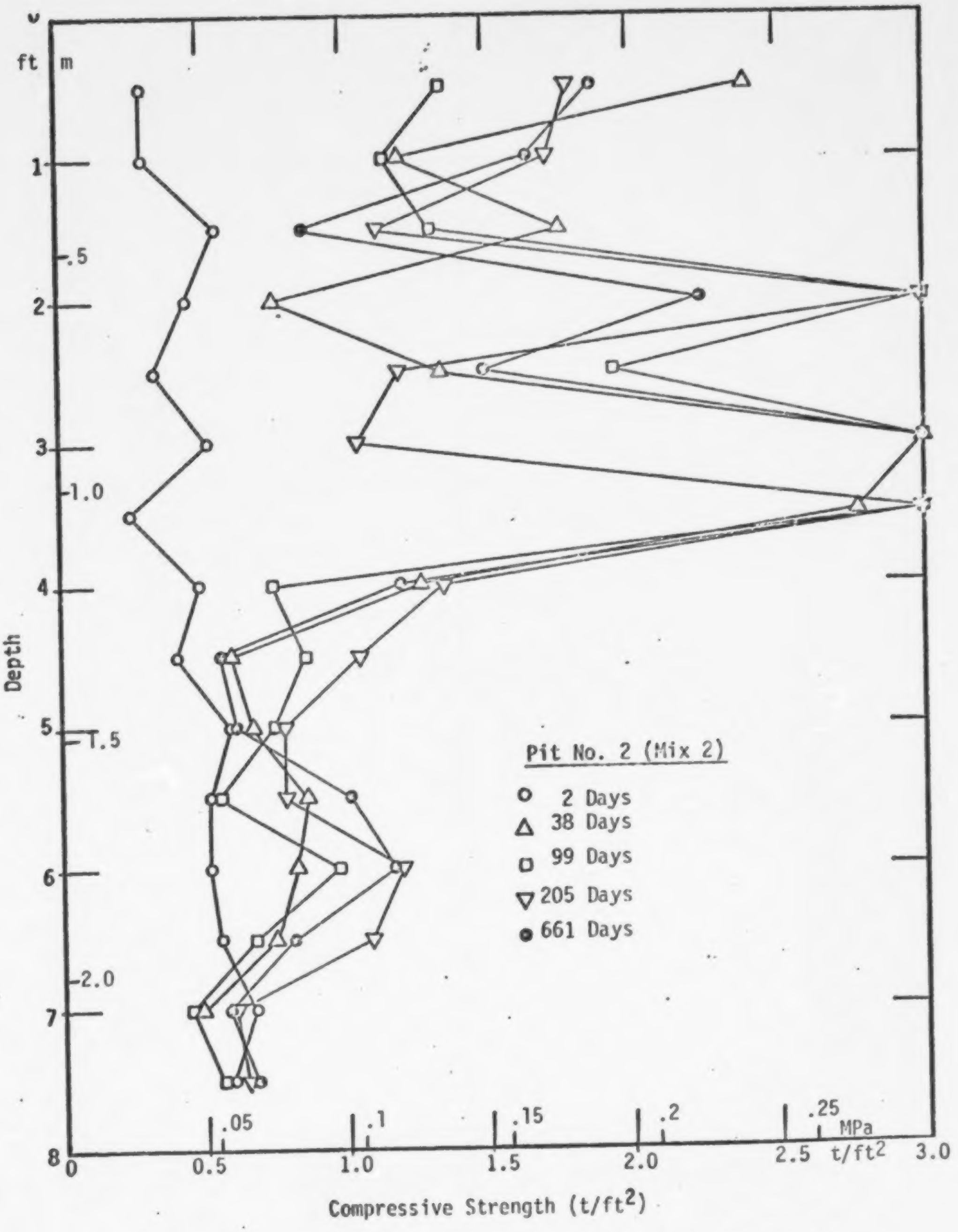

Figure E-2 In-Situ Strength Values for Pit 2. (Mix 2)

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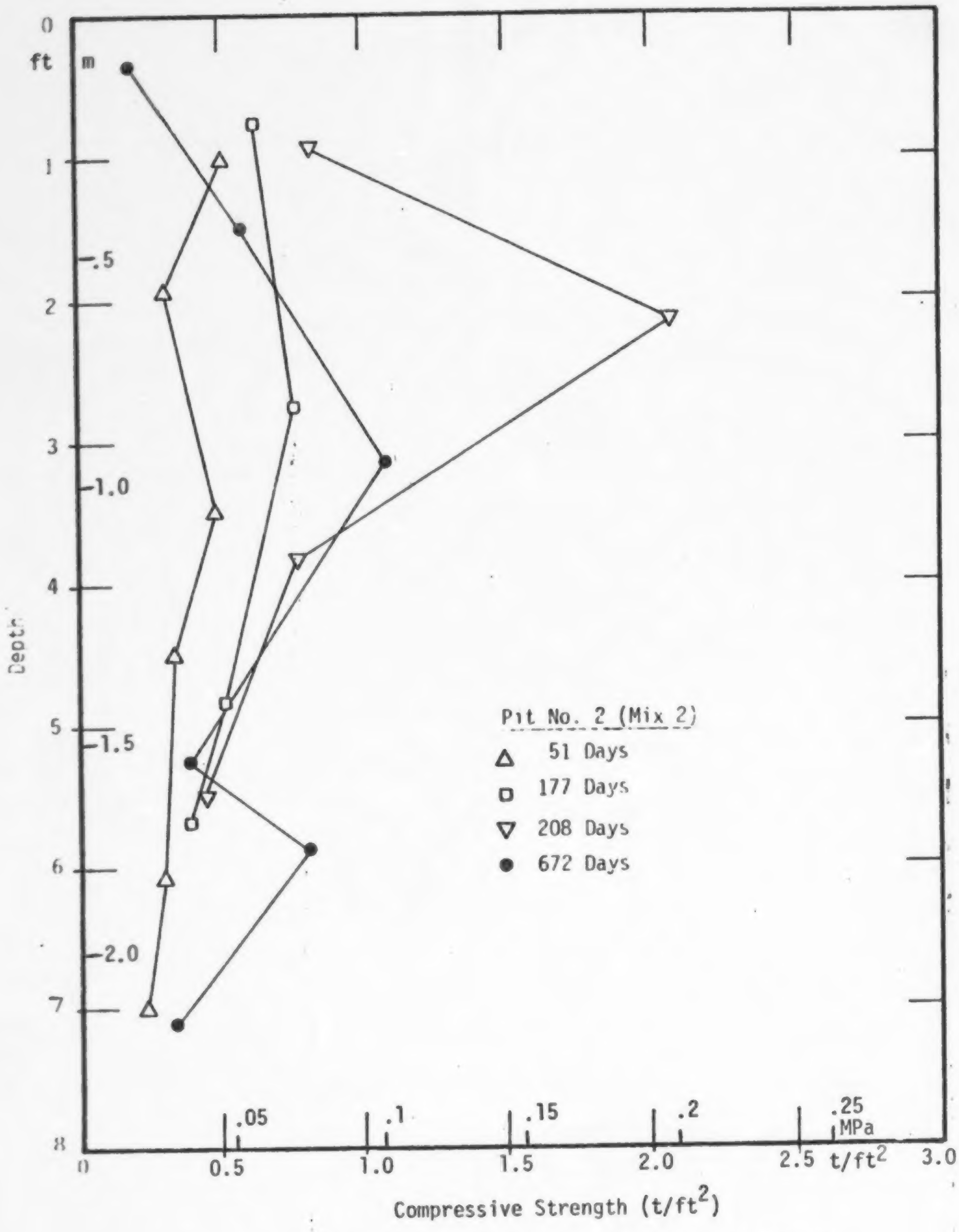

Figure E-3 Laboratory Strength Values for Pit No. 2 (Mix 2)

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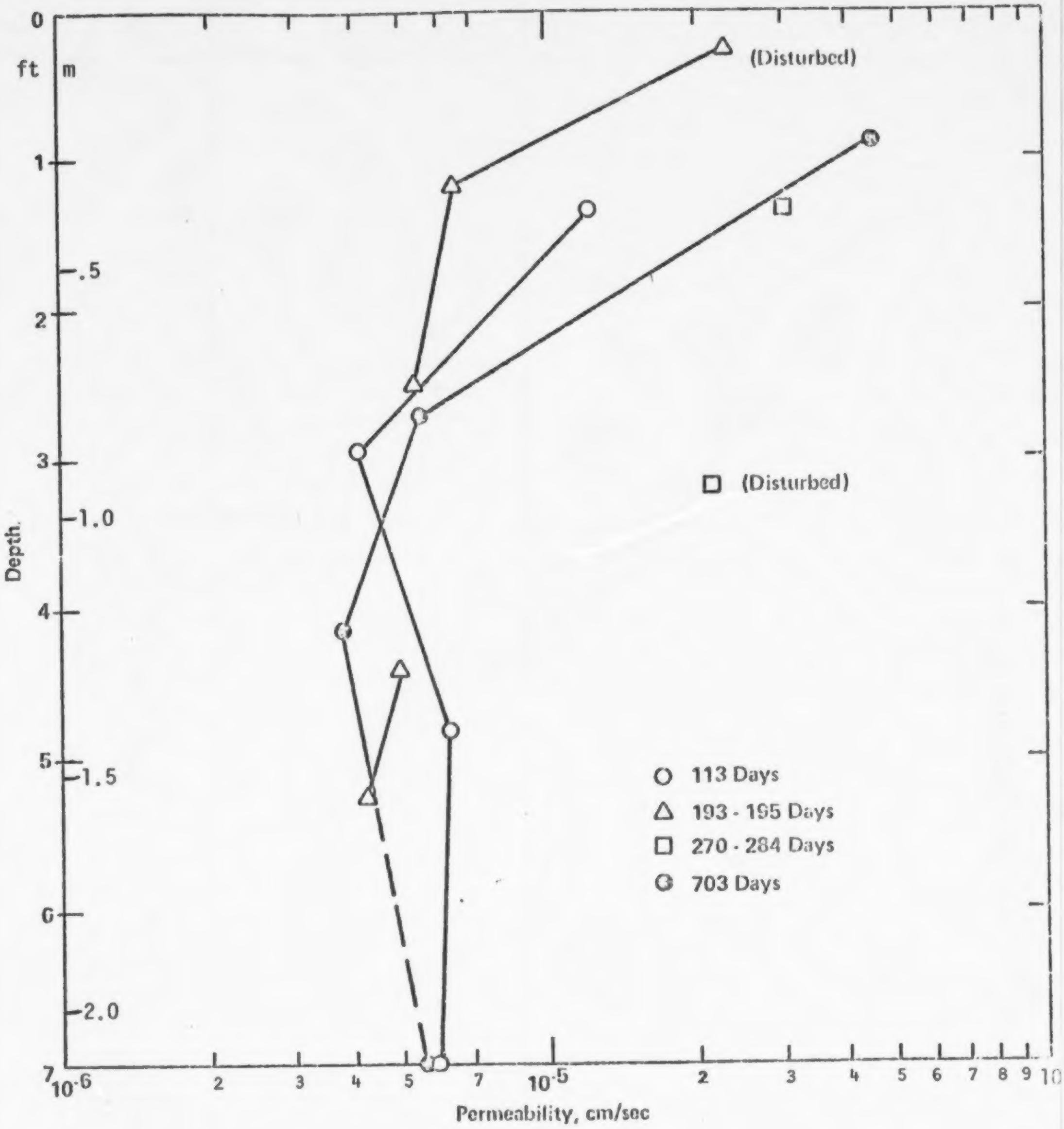

FIGURE E-4
Pit No. 2 (Mix 2)
Permeability Values

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allowed to slowly thaw in the laboratory. At seven days after placement, the in-situ unconfined compressive strength was .048 to .067 MPa (0.50 to 0.70 t/ft^2) while the thawed samples showed strengths of only .019 to .024 MPa (0.20 to 0.25 t/ft^2). The difference between the values apparently was due to freezing which gave a false high strength reading. Thirty-day in-situ tests on partially frozen sludge gave higher results than the values obtained on thawed samples tested 51 days after placement .072 MPa (0.75 t/ft^2) in-situ vs. .024 MPa (0.25 t/ft^2) on lab samples. The entire pool appeared to be frozen by the end of February 1977, 90 days after placement. At that time, the in-situ apparent strength was .12 to .20 MPa (1.2 to 2.1 t/ft^2), but negligible strength was found after thaw in the laboratory. Testing on June 28, 1977 after 216 days an in-situ unconfined compressive strength of .077 to .12 MPa (0.80 to 1.20 t/ft^2) was recorded with the higher value obtained near the surface of the deposit. A sample tested in the laboratory showed a strength slightly less than .048 MPa (0.50 t/ft^2). Laboratory tests on Mix 4 prior to field placement had shown an unconfined compressive strength of .44 MPa (4.6 t/ft^2). (1) When the pool was sampled on September 19, 1978, the in-situ strength values varied from .017 to .021 MPa (0.18 to 0.22 t/ft^2) with the higher value recorded closer to the surface of the deposit. It appears that a drastic reduction in strength of the material occurred as a result of weathering during the intervening year's time. (Figure E-5)

Samples obtained from the pool on September 19, 1978 (664 days) were tested in the laboratory in unconfined compression. These samples showed unconfined compressive strengths slightly higher than the in-situ strength values obtained at the site: from .019 to .032 MPa (0.196 to 0.336 t/ft^2). This is the only instance in the testing program in which the laboratory strength values were higher than thein-situ test values. Because of disturbance of the material during the sampling operation, the transport of samples to the laboratory and the preparation of the samples usually results in values lower than those found during in-situ testing, Weathering effects appear to have severely disturbed the mixture and greatly reduced the strength of the material.

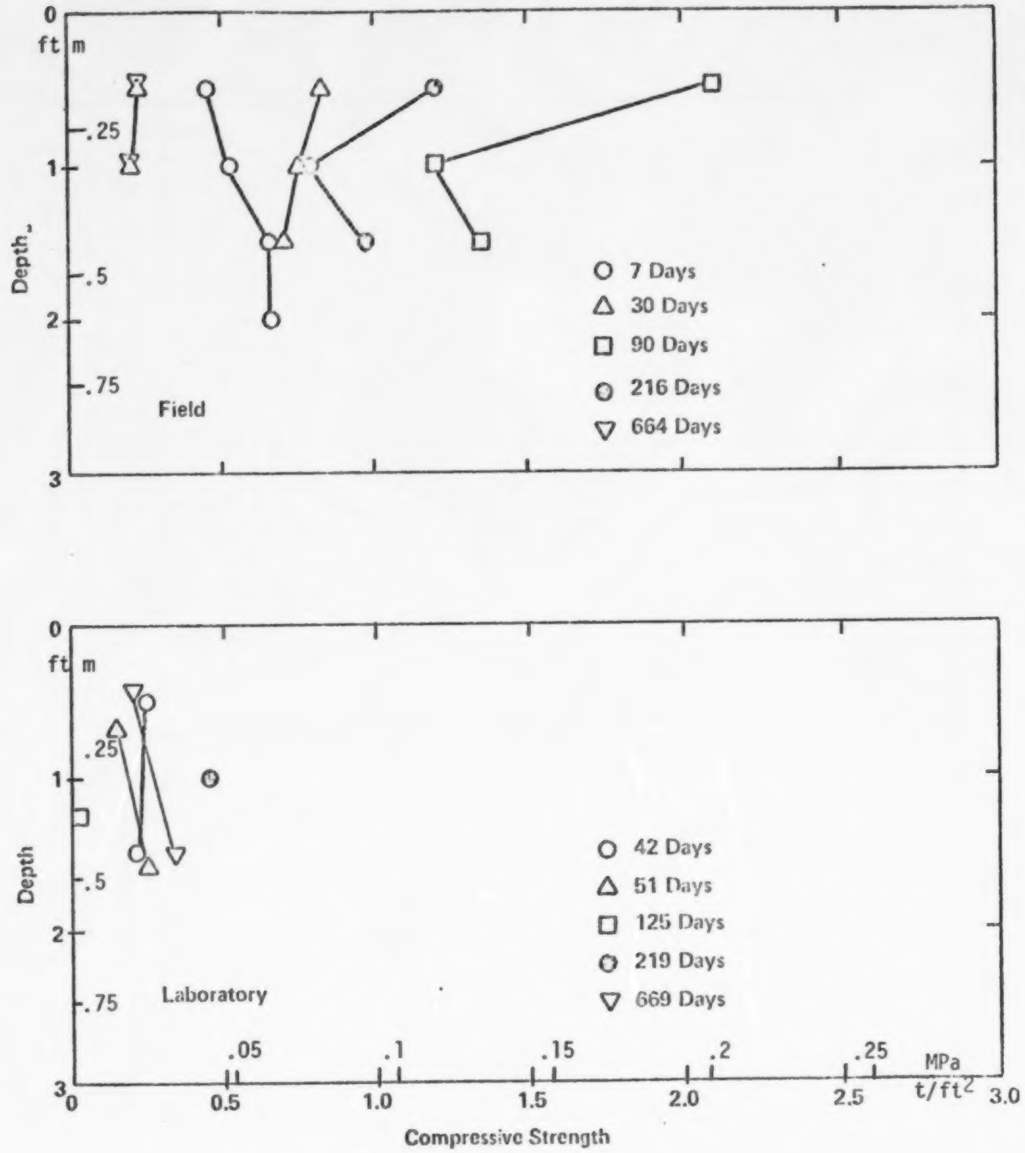

FIGURE E-5
Pool No. 2
Strength Values (Mix 4)

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Permeability - Permeability tests were performed on samples obtained from Pool 2 as soon as samples could be thawed and prepared. The values of coefficient of permeability for test samples taken nominally at 30 days and at 90 days after placement varied from about 0.7 to 1.6 x 10^{-5} cm/sec. A test was run on a sample obtained on September 19, 1978 and the corresponding permeability value obtained for that sample was 5.2 x 10^{-6} cm/sec. Laboratory tests on Mix 4 prior to field placement had indicated a coefficient of permeability of 4.5 x 10^{-7} cm/sec.

Mix 6 (Pool 4)

Mix 6, as designed, consisted of the following:

55% Solids Cake
3% Dry Carbide Lime
1:1 Fly Ash to Dry Scrubber Solids

However, Mix 6 was prepared using a cement mixer truck, rather than the Bauer disc mill. Alternate feeding of filter cake, fly ash, and lime into the cement mixer was necessary in order to avoid plugging the mixer inlet.

When the material was discharged at the samll impoundment site #4, it was necessary to add additional fly ash to the mixture in order to produce a mixture dry enough to discharge from the truck chute. As a result, Mix 6 as placed contained considerably more fly ash than was originally planned.

Strength and Permeability - The mix, as placed in the impoundment was almost impossible to compact and consisted of uneven layers of high and low fly ash content. The surface of Pool 4 had large "black snowballs" of fly ash-coated sludge. As a result, it was decided that strength and permeability tests would have little meaning in relation to previous laboratory tests. Thus, only leachate analyses were performed on Mix 6 during the field phase.

Mix 7 (Pool 10)

Pool 10 was filled in a 24-hour period on August 1 and 2, 1977, following conversion to a pneumatic fly ash-feeding system, with the following nominal composition:

65% commercial lime sludge
1:1 fly ash to dry sludge

The nominal solids content of the mix was 78.8%, or 27% moisture content. The actual mixture had a solids range of 58 to 65%.

Strength - In-situ strength measurements were made nine days after placement. The strength values varied from about .062 MPa (0.650 t/ft^2) to about .12 MPa (1.30 t/ft^2). Samples taken at this time crumbled and broke apart when they were extruded from the sampling tube. One of the samples, though cracked and full of coids, supported more than .048 MPa (0.5 t/ft^2) before it failed abruptly. No permeability tests could be performed on these cracked samples. Sample disturbance was severe due to the high fly ash content and lack of fixative.

After seven weeks, the surface of the deposit had hardened to a condition so that the vane shear device could not be inserted. Samples for laboratory evaluation were obtained with considerable effort. These samples yielded compressive strength values of .16 MPa (1.65 t/ft^2) and .081 MPa (0.85 t/ft^2) respectively. Due to sample cracks and crumbling no permeability tests were possible. (Figure E-6)

After 413 days, samples were obtained. Field strengths varied from .20 to .27 MPa (2.10 to 2.78 t/ft^2). Laboratory tests on Mix 7 prior to field testing had shown a 60-day unconfined compressive strength of .29 MPa (3.0 t/ft^2).

Permeability - Because of the extremely friable and crumbly nature of the sample obtained from Pool 10 all during the testing program, it was not possible to perform permeability tests on samples from the pool. Laboratory tests prior to field studies had indicated a coefficient of permeability of 7×10^{-6} cm/sec. for undisturbed samples of Mix 7.

Mix 8 (Pit 3 and Pool 6)

This mix had a nominal solids content of 60.5%, with individual batches

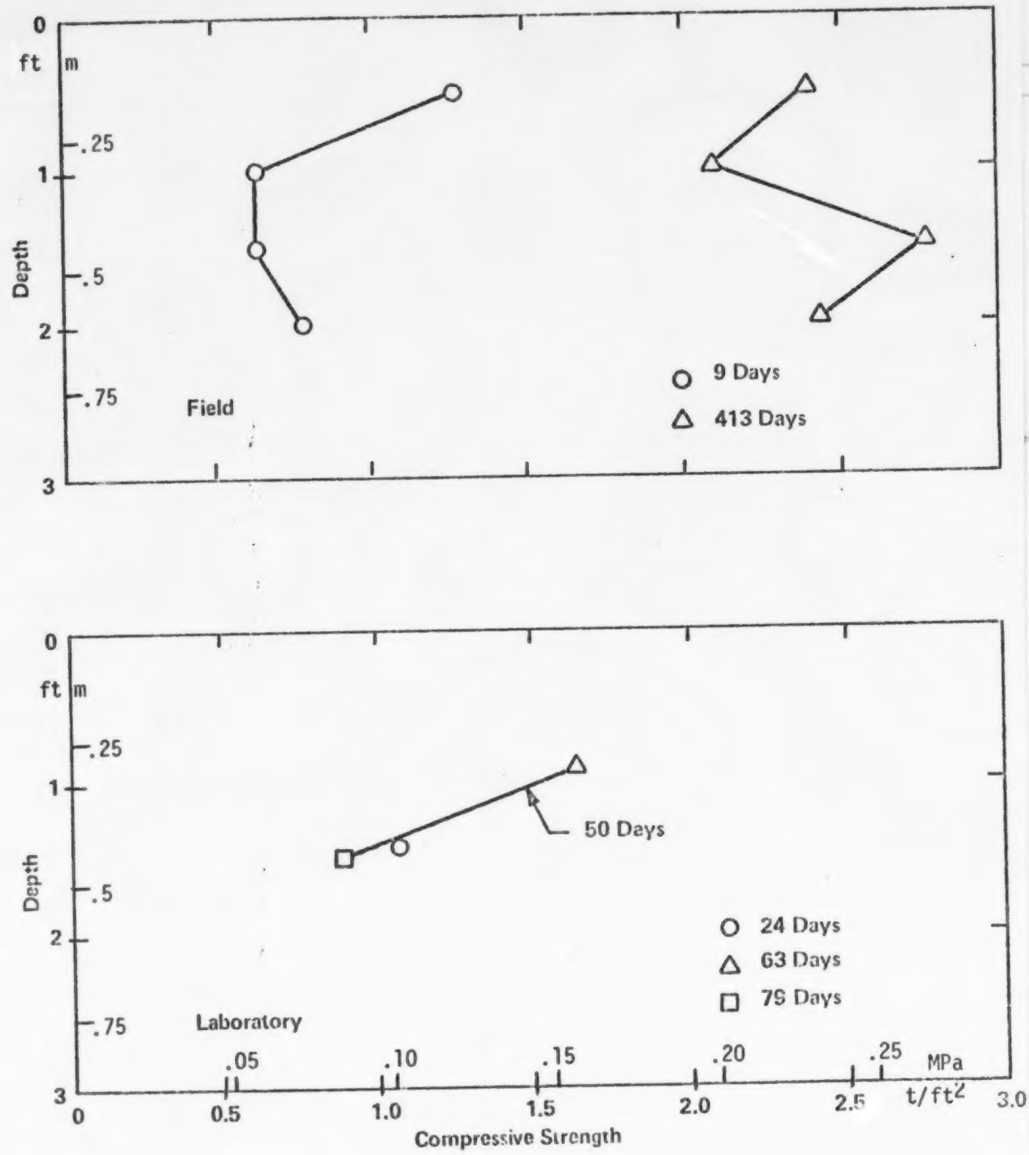

FIGURE E-6
Pool No. 10 (Mix 7)
Strength Values

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varying from 45-70% with the following composition:

50% commercial lime sludge
0.5:1 fly ash to dry sludge
3% dry commercial lime fixative

Strength - The in-situ strengths, obtained three days after placement, varied from .096 to .29 MPa (0.10 to more than 3.0 t/ft^2). The very stiff zone at a depth of 1.4 to 1.5m (4.5 to 5 feet) corresponded approximately to the surface of the first day of filling of the deposit.

Laboratory tests on the samples which were obtained with minimum disturbance during sampling showed strengths varying from about .12 to .17 MPa (1.3 to 1.8 t/ft^2) at a moisture contents of 40% to 53% (See Figure E-7). Samples again were obtained 39 days after placement, but only with great difficulty. When these severely disturbed samples were tested, 48 days after placement, compressive strength values ranged from .19 to .21 MPa (0.20 to 2.2 t/ft^2).

Initial laboratory tests on Mix 8, prior to the field phase, had shown a 60-day compressive strength of .70 MPa (7.3 t/ft^2). (Table 3)

An attempt was made to obtain in-situ strength values from this deposit after 461 days after placement, but it was impossible to insert the vane shear device to a significant depth in the deposit. Core samples obtained at this time were tested in the laboratory. The upper .9 to 1.2m (3 to 4 feet) of this deposit appear to have deteriorated somewhat through the effects of weathering. However, below a depth of about 1.2m (4 feet) the material appears to be intact and the shear strength in the most recent test varied from slightly more than .14 to .29 MPa (1.5 to more than 3.0 t/ft^2) (Figure E-7). These samples did not display the disturbance which was apparent in the samples tested earlier because a rotary coring device was utilized in obtaining the later samples.

Permeability - Two samples obtained from Pit 3 were subjected to permeability tests 49 days after placement and 60 days after placement. These two tests

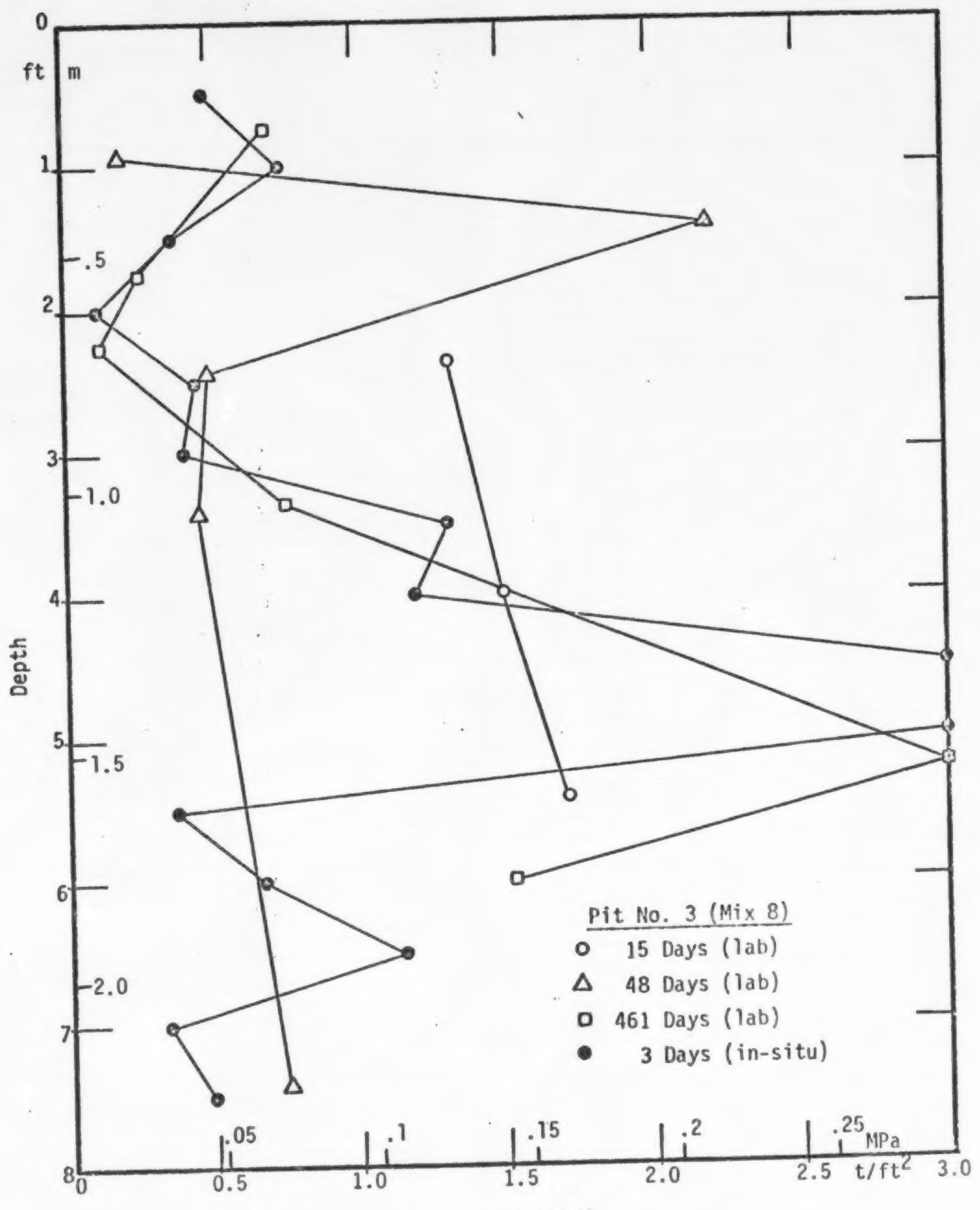

Figure E-7 Strength Values for Pit 3. (Mix 8)

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gave indicated values of coefficient of permeability of 7 x 10^{-6} cm/sec and 2 x 10^{-6} cm/sec at moisture contents of 26% and 37%, respectively. Three samples taken after 72 days with moisture contents of 41 to 45% yielded permeability values of 1.4 x 10^{-5} cm/sec, and 0.9 x 10^{-6} cm/sec. (Figure E-8)

Laboratory tests on Mix 8 prior to field placement had shown a coefficient of permeability of 4.1 x 10^{-6} cm/sec. Weathering apparently increased the permeability of the upper portion of the impoundment, a situation which could have been avoided by proper compacting.

Mix 9 (Pool 5)

The mixture had a nominal solids content of 71.7% while the measured solids content of individual batches ranged 56-59% with the following composition:

50% commercial lime sludge
1.5:1 fly ash to dry sludge
3% dry commercial lime.

Strength - Samples were obtained immediately after filling of the impoundment and in-situ strength measurements made. The strength values varied from .038 to .062 MPa (0.400 to about 0.650 t/ft^2). A sample tested in the laboratory the next day showed only slight disturbance and yielded a strength value of about .052 MPa (0.55 t/ft^2). Laboratory tests prior to field placement had shown a 60-day compressive strength of 1.19 MPa (12.5 t/ft^2). (Table 3)

Thirty-one days after placement, the sludge had hardened sufficiently that the vane shear strength device could not be inserted into the deposit. Samples were obtained by driving thin-walled Shelby sampling tubes into the sludge. The high fly ash content of this mix made the material extremely brittle and susceptible to disturbance. After 445 days, it was impossible to obtain an in-situ strength reading because the vane shear device could not be inserted.

One sample tested in the laboratory yielded a strength value of .13 MPa (1.39

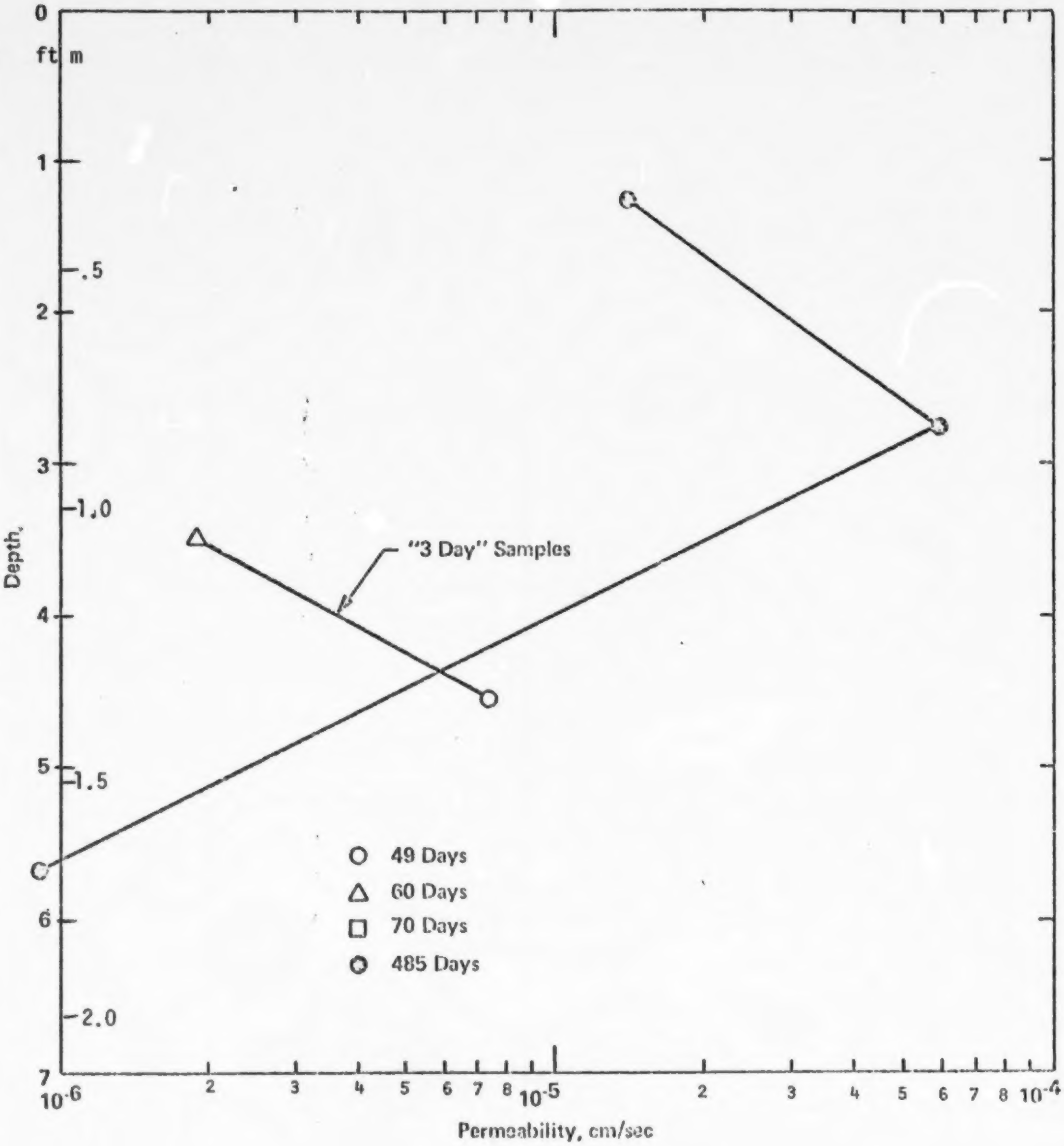

FIGURE E-8
Pit No. 3 (Mix 8)
Permeability Values

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t/ft^2) with a content established for the pool.

The indicated coefficient of permeability of a sample 59 days after placement was 4.5 x 10^{-6} cm/sec, compared to a coefficient of 5.7 x 10^{-7} cm/sec obtained in the laboratory prior to field placement on a similar undisturbed mixture.

Permeability - The samples taken from Pool 5 after 445 days were so friable and brittle it was not possible to prepare a field sample for permeability testing in the laboratory.

Mix 10 (Pool 9)

Mix 10 contained Portland cement as the stabilizing agent; the mix composition was:

50% commercial lime sludge
1:1 fly ash to sludge
3% dry Portland cement fixative

This mixture was placed into Pool 9 at an initial solids content of approximately 67%, individual batches ranging from 64 to 68% solids.

Strength and Permeability - The strength of this material exceeded the capacity of the vane shear device .29 MPa ($>$3.0 t/ft^2) when tested 10 days after placement. A core sample taken at 10 days and tested at the University of Louisville had a compressive strength of .31 MPa (3.2 t/ft^2) even though the sample was significantly disturbed during collection.

Subsequent testing at 51 and 416 days again showed the high strength achieved by Mix 10. The material was too hard to insert the vane shear device and collection of core samples was difficult.

The samples that were collected at 51 days had hight strengths .71 MPa (7.4 t/ft^2), but due to cracking, permeability tests were not run. Samples collected at 416 days had unconfined compressive strengths of .49 MPa (5.1 t/ft^2) and permeabilities of $\approx$3.2 x 10^{-5} cm/sec. The values measured in the laboratory for Mix 10 were: Strength - .52 MPa (5.4 t/ft^2) Permeability - 5 x 10^{-5} cm/sec.

Mix 11 (Pit 5, Pool 7)

50% commercial lime sludge
1:1 fly ash to dry sludge
3% dry commercial lime fixative

Strength - Within 10 days after placement, the surface of the mix could not be penetrated with the vane shear device. Samples, obtained with great difficulty, were significantly disturbed. Tests on these samples showed strengths of from .072 to .19 MPa (0.75 to 2.0 t/ft^2) with the higher value obtained from a sample taken near the surface of the deposit. (Figure E-9) The moisture contents of the samples were about 41%, slightly lower than the nominal mix placement moisture content of 50%.

Samples tested in the laboratory 466 days after the material had been placed provided compressive strength values of .11 to .14 MPa (1.1 to 1.5 t/ft^2) at a solids content of approximately 70% (~39% moisture). Laboratory tests on samples of Mix 11 performed prior to field placement had shown compressive strength up to .81 MPa (8.5 t/ft^2) at a solids content of 67%. (Table 3)

Because of the high strength results obtained from mixtures 11 and 12 (Pits 5 and 4) during in-situ and laboratory testing, plate load tests were conducted on the impoundments containing the higher strength mixtures. In these tests, a steel loading plate 30.5 x 30.5cm by 12 inches was placed on the surface of the mix material in each of the pits after the surface had been swept free of loose debris and had been liveled. Dial gauges were positioned at the corners of the steel plate to measure the downward movement of plate corners under load. A hydraulic jack was utilized to exert downward force on the steel places used in the loading tests with removal of the load and reloading for two cycles, to investigate the rebound characteristics of the material. The results of this test on Mix 11 (Pit 5) are shown in Figure E-10. During the loading to more than .77 MPa (8 t/ft^2) a settlement

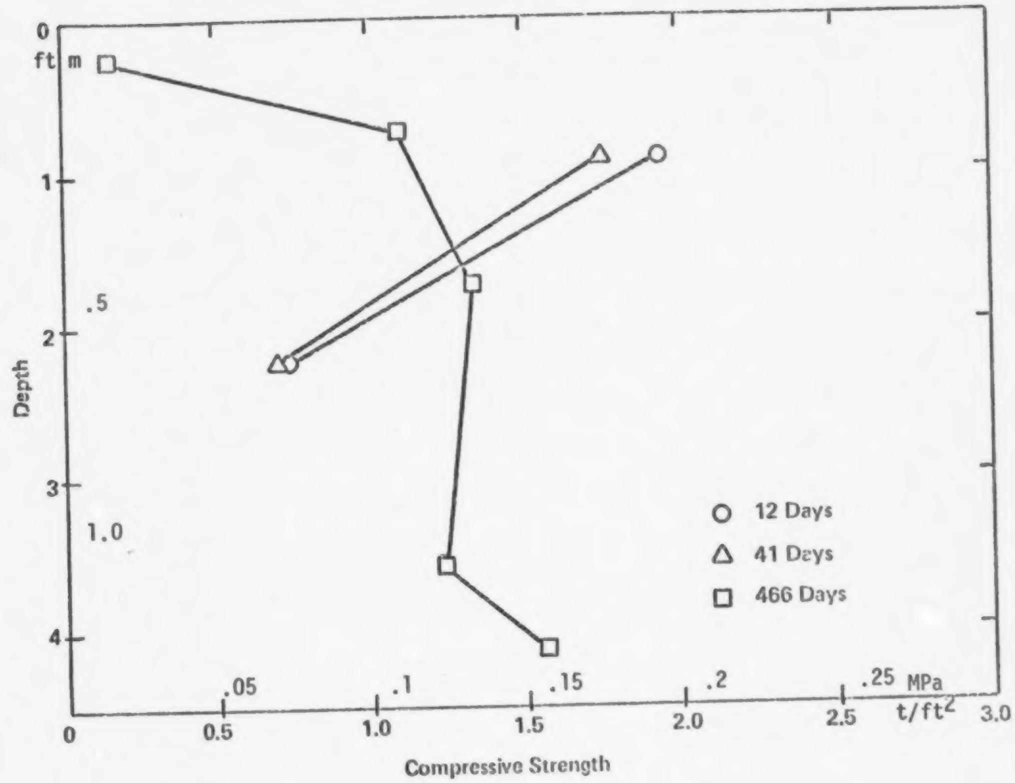

FIGURE E-9
Pit No. 5 (Mix 11)
Laboratory Strength Values

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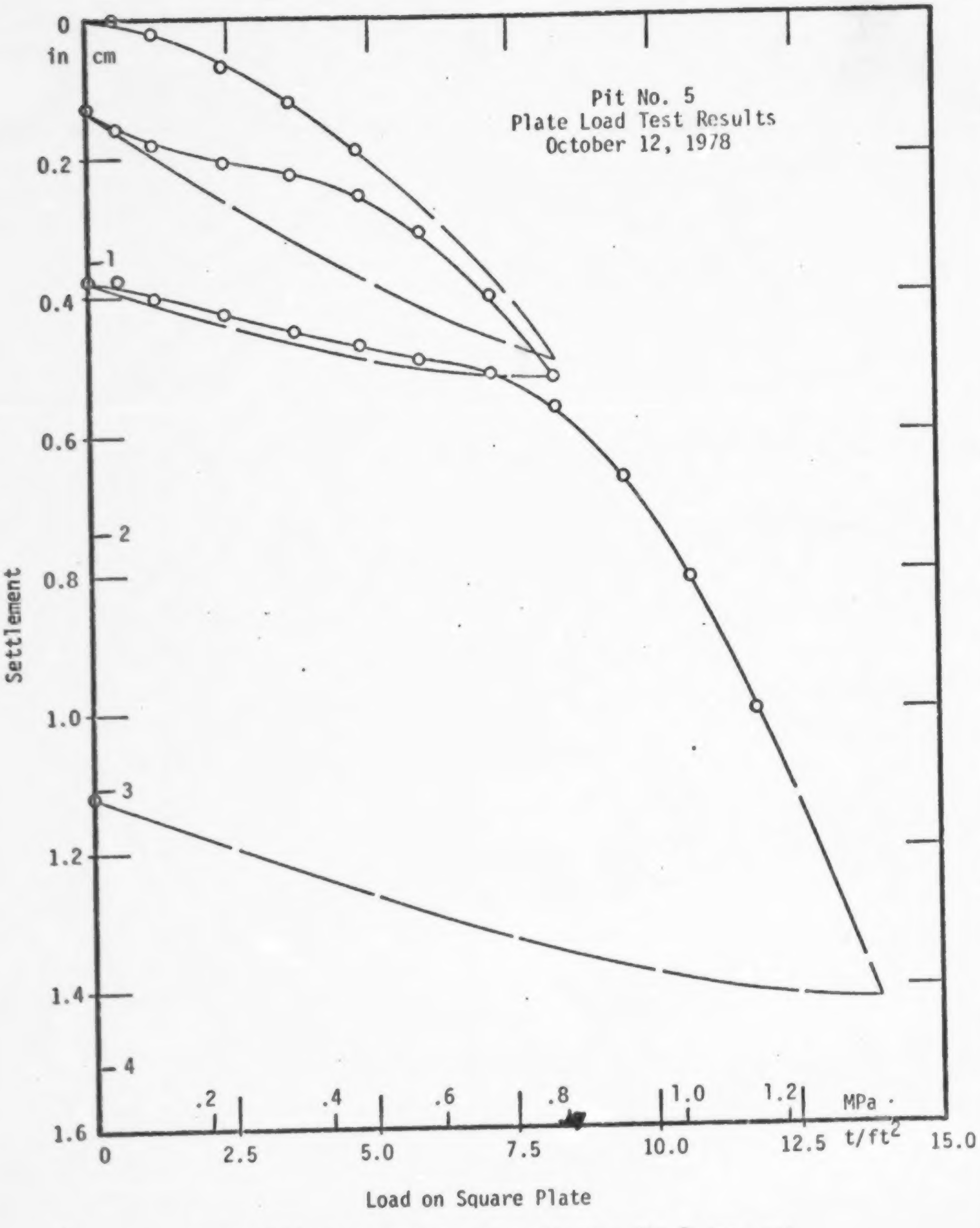

Figure E-10 Plate Load Test Results for Pit 5. (Mix 11)

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EPA-287 (Cin.)
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of approximately 1.3cm (0.5 in.) occurred. When the load was removed, the plate rose producing a net settlement of only about 33cm (0.3 in.). When the load was re-applied, the net settlement under the .77 MPa (8 t/ft^2) removed after the second loading a permanent net settlement of almost 1.0cm (0.4 in.) was noted. A third cycle of loading extended to pressures greater than 1.3 MPa (13.75 t/ft^2) and produced a settlement of 1.3cm (1.4 in.). When the load was removed, a net settlement of 2.8cm (1.1 in.) had occurred. This behavior indicates that the material in Pit 5 bear very high foundation loads.

Permeability - Permeability tests were performed on samples taken 10 days after placement of the material. These tests were performed 57 days after placement and 90 days after placement. The obtained coefficients of permeability for these samples were 4.5 x 10^{-6} cm/sec for the 57-day-old sample, and 16.5 x 10^{-6} cm/sec for the 90-day-old sample.

Laboratory permeability tests were run 484 days after placement of the material in the field. The mositure content of these samples was 45% (60% solids). These tests showed coefficients of permeability of 1.2 x 10^{-6} cm/sec for the sample taken from a depth of 30.5-45.7cm (12-18 in) and 1.4 x 10^{-6} cm/sec for the sample taken from a depth of 86 to 2cm (34-40 in.). Laboratory tests on Mix 11 prior to field studies had shown a coefficient of permeability of 2.9 x 10^{-6} cm/sec(1) to 10^{-7} cm/sec that no leachate sample was available until the 270 day sampling period. From their through the final sampling at 450 days the trace elements were found at concentrations well below the RCRA limits. The pH measured at this time was 4.5 to 5.2.

Mix 12 (Pit 4)

This mix consisted of:
50% commercial lime sludge
1:1 fly ash to dry sludge solids
3% $Ca(OH)_2$

Both Pool 8 and Pit 4 were filled with Mix 12. The initial solids content of the mix was 67%.

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Samples were obtained and in-situ strength values were measured immediately after Pit 4 was filled. The in-situ strength values varied from .067 to .26 MPa (0.7 to 2.7 t/ft^2) as shown in Figure E-11. Unconfined compression tests in the University of Louisville lab on core samples gave values of .048 to .096 MPa (0.5 to 1.0 t/ft^2) from one-half to one-third of the in-situ strengths for the same depths. The lower lab strength values resulted from the inevitable sample disturbance that occurred when sampling tubes were hammered into the brittle but stiff mix in Pit 4. Permeability tests could not be run on these samples due to this cracking.

The mix had hardened after 31 days and it was not possible to insert the vane shear device for in-situ strength tests. Core samples collected at this time had compressive strengths of (3.0 and 1.3 t/ft^2). See Figure E-11). Cracks throughout the sample prevented permeability testing.

Core samples were again taken at 452 days after placement. Dure to the hardness of the surface, the vane shear device could not be used. Core samples were obtained by using a drilling rig to force the sampling tubes into the pit. The unconfined compressive strength values ranged from 0.5 t/ft^2 for a sample taken between 5.1 and 15.2cm (2 and 6 in.) depth to .19 MPa for a sample from 58 to 69cm (23 to 27 in.) depth (Figure E-11). Although these samples had small cracks and crevices, permeability tests were run; the coefficients of permeability for samples taken at 452 days were 3.0×10^{-6} cm/sec, 3.3×10^{-6} cm/sec and 1.8×10^{-6} cm/sec.

Because the samples from Pit 4 showed considerable strength even in the highly disturbed core samples, a plate load test was run at the test site to evaluate in-situ strength. In the plate load tests, a steel loading plate 30.5 x 30.5cm (12 x 12 in.) was placed on the surface of the mix material. A hydraulic jack was used to exert a downward force on the steel plate; dial gauges measured the downward movement of the plate corners under load. The results of these loading tests are shwon in Figure E-12. In Pit 4, a total load of 1.34 MPa (14 t/ft^2) caused a settlement of only 3.1cm (1.2 in.). These loading tests indicate that the Mix 12 would be capable of bearing significant foundation loads.

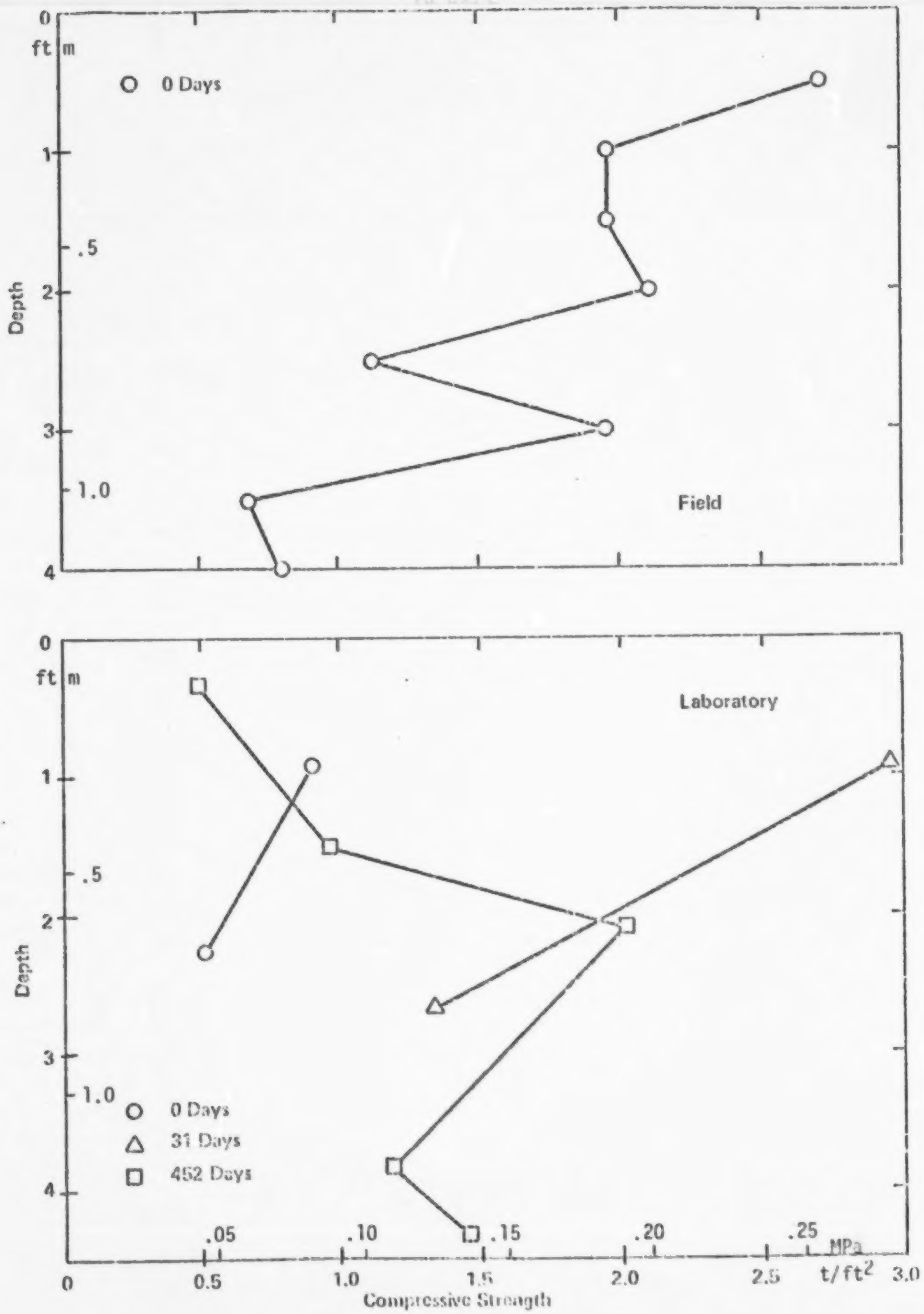

FIGURE E-11 Pit No. 4 (Mix 12)
Strength Values

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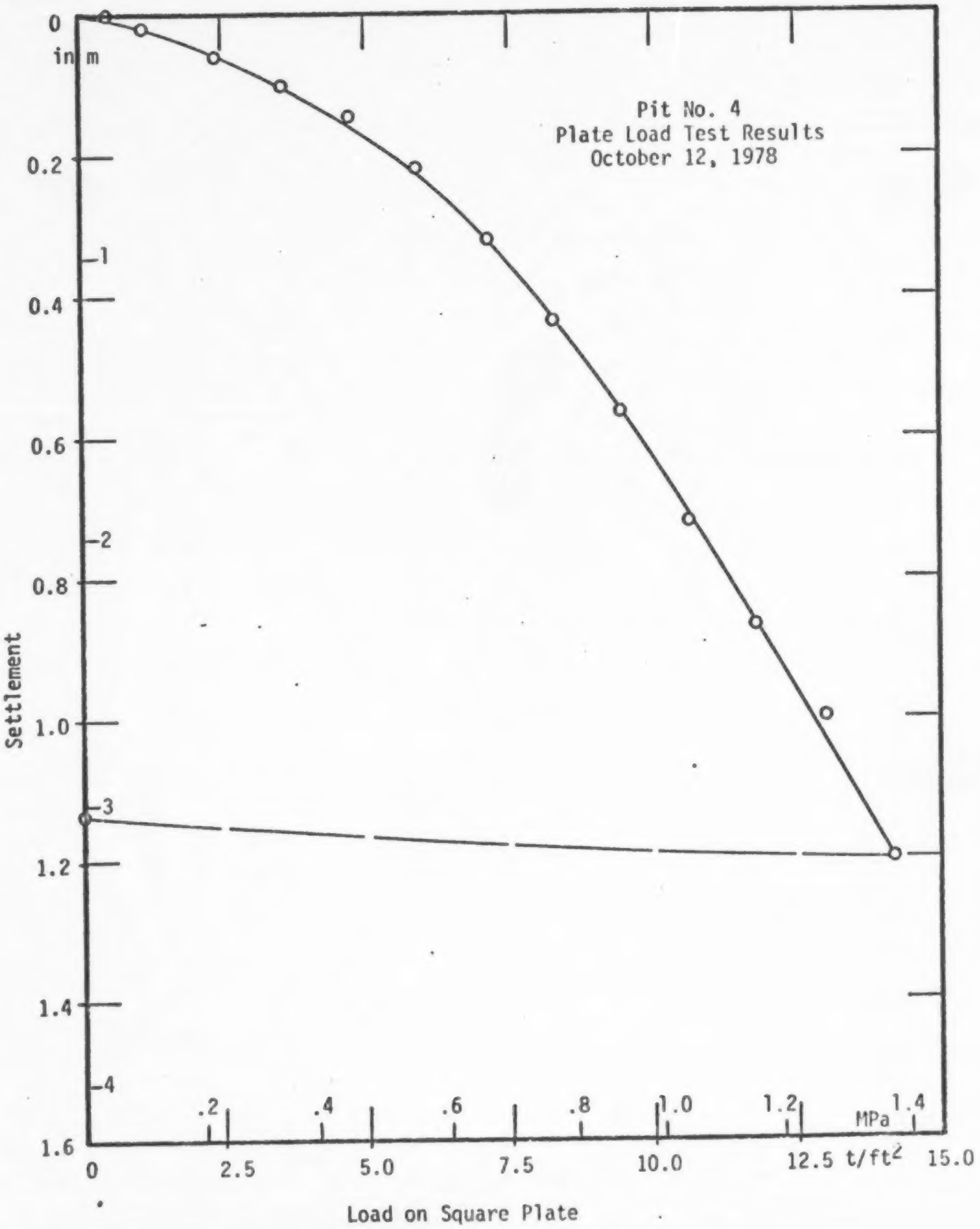

Figure E-12 Plate Load Test Results for Pit 4. (MIX 12)

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APPENDIX F

GROUND WATER HYDROLOGY

The local soil hydrology at the disposal site was studied for the purposes of siting test impoundments. Information obtained at the time of the completion of the study (February 1977) is included.

GROUNDWATER HYDROLOGY

Introduction

The demonstration of land disposal of flue gas cleaning sludges currently underway at the Cane Run Plant of the Louisville Gas & Electric Company necessarily involves a consideration of the flow of groundwater through the soils at the site. Consequently, a thorough study has been conducted to determine the influence of bedrock characteristics and soil properties on the flow of water beneath the ground surface at this site. In general, the sand and gravel which underlie the site constitute an excellent reservoir for groundwater, but the groundwater elevation (naturally) is 30-40 feet below the ground surface. Also, the surface of the groundwater has been depressed in recent years through pumping on the plant site and in the Rubbertown area to the north of the site. As a consequence of these conditions, it is apparent that very little potential for groundwater contamination from sludge leachate exists at the site.

Geology

The major geologic structure in the Jefferson County area consists of layers of sedimentary rock which form the western portion of a large dome centered in the Lexington area. The surface of the dome has been removed by erosion during the millions of years since the rock strata were originally deposited. As a result, the oldest rocks in the state are to be found in the Lexington region, and progressively younger strata are exposed on a line from Lexington westward. The rock layers in the Jefferson County area consist of limestones and shales. The oldest rocks in the area are found in eastern Jefferson County. On a line from eastern Jefferson County toward the LG&E plant site in the far western portion of the county, the sequence of rock units is progressively younger: Silurian, Devonian, and Mississippian. In general, the bedrock formations are fairly uniform in thickness, and dip slightly toward the west at a rate of about 30-40 feet per mile. The Silurian Age

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materials are limestones, notably the Louisville limestone. The Devonian Age strata include the Jeffersonville and the Sellersburg limestones, through the central portion of the city. In the northwestern and far western portions of the county, the Devonian materials include the very thick New Albany shale. In the far southwestern portion of the county, west and southwest of Shively, Mississippian-age rocks are found, notably the New Providence shale. These rock units are shown in Figure F 1.

Prior to the onset of the Ice Age approximately 1 million years ago, the Ohio River did not exist as it does today. The pre-glacial drainage patterns in the area included flow of water in the channel now occupied by the Ohio River, only to the west of Jefferson County. The eastward limit of this drainage basin was a belt of Devonian and Mississippian rocks which are known locally as the Knobs. In the area of the LG&E plant, the Knobs are found to the west and southwest. The drainage patterns to the east of the plant site, prior to the Ice Age, included flow northeastward into a dominant drainage pattern along the present valley of the Kentucky River. During the Ice Age, these drainage patterns were rearranged and the present valley of the Ohio River was established. A notch was eroded through the Knobs and the river cut a valley into the bedrock to a depth of 150 to 170 feet below the present riverbank elevations. During the Ice Age, sea level was several hundred feet lower than it is at the present time, causing widespread erosion throughout the Midwest.

The topography of a deep and wide stream valley, with numerous tributaries established in the limestones and shales of the Jefferson County area, which was established during the Ice Age, was covered with sediments at the close of the glacial periods when the ice melted. The meltwaters from the receding glaciers deposited a great thickness of sand and gravel over the bedrock surface. In Figure F.1, the area along the Ohio River is shown to be covered

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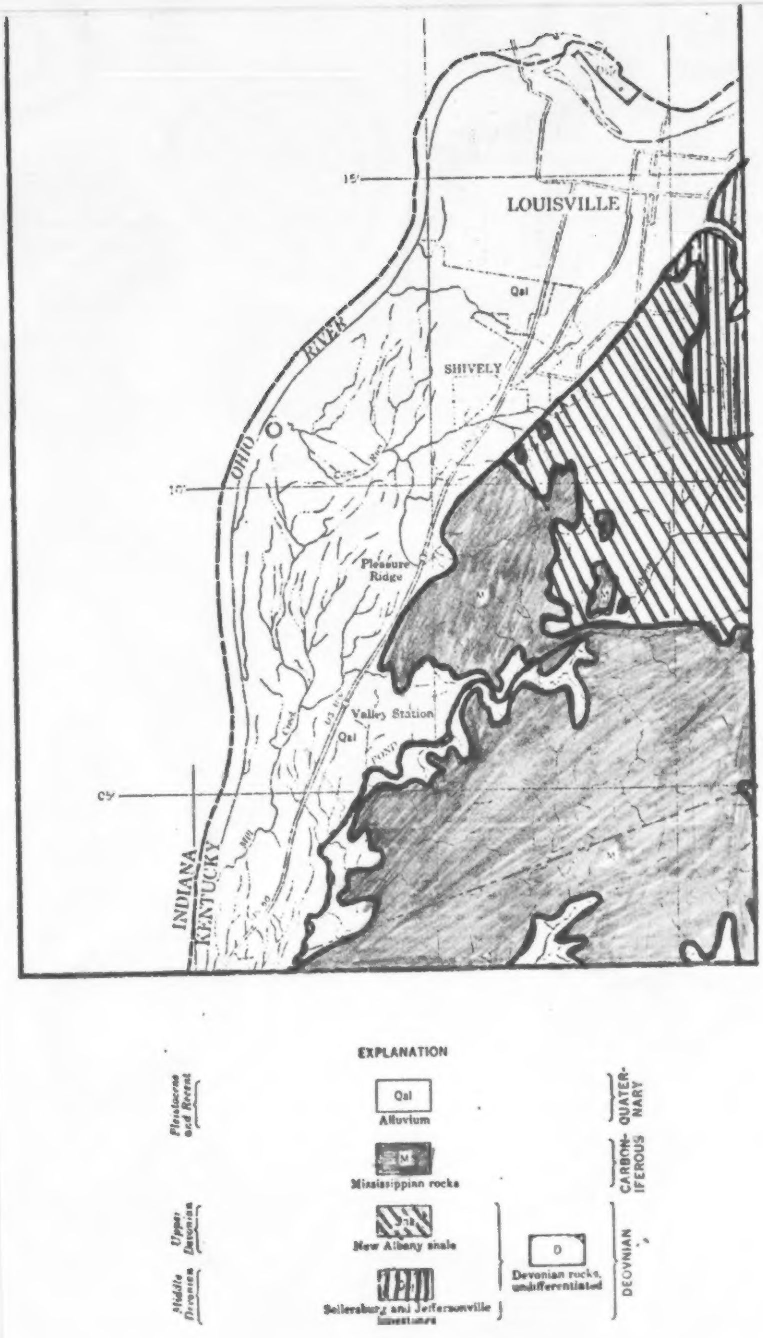
LOUISVILLE
15'
Qal
SHIVELY
OHIO RIVER
10'
Pleasure Ridge
Valley Station
Qal
05'
INDIANA
KENTUCKY
M
D
EXPLANATION
Pleistocene and Recent
Qal
Alluvium
QUATER-NARY
M
Mississippian rocks
CARBON-IFEROUS
Upper Devonian
New Albany shale
Middle Devonian
Sellersburg and Jeffersonville limestones
D
Devonian rocks, undifferentiated
DEOVNIAN

FIG. F.1. GEOLOGY OF THE STUDY AREA

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with alluvium. Most of this alluvium is of Pleistocene (Ice Age) origin. The alluvial materials consist of clean sands and gravels for a depth of as much as 100 feet. Generally, the gravels and coarse sands are found closest to the bedrock surface, and the sediments become progressively finer as the present ground surface is approached. In the upper layers of the alluvium, fine silts and some clay layers were deposited in the final stages of the glacial epoch.

In Recent times, rather thin layers of silt and clay have been deposited in combination with thin lenses of sand and silty sand. This deposition has occurred during the annual flooding cycles of the present Ohio River. As a consequence of this activity, a very heterogeneous pattern of thin layers of silt, clay and sand are to be found in the uppermost few feet of soil beneath the ground surface at the LG&E plant site.

Groundwater Occurrence

Precipitation is the primary source of groundwater in all situations; however, the supply of groundwater may be obtained partially from direct infiltration through the ground surface and partially through flow in bedrock formations which are supplied from the ground surface at a remote location. In the Jefferson County area, precipitation averages approximately 41.5 inches per year. This precipitation flows through the surface of the soils above the rock formations; it enters the Pleistocene sand and gravel materials as well as the consolidated limestone and shale bedrock formations.

The Louisville, Jeffersonville and Sellersburg limestones mentioned previously underlie the sand and gravel valley fill under the central part of Louisville and are exposed in the northern, central, and south-central parts of Jefferson County. These formations constitute an aquifer of only secondary importance. Water in this system of limestone strata moves through discontinuities such as joints and solution cavities in the rock. In the upland areas in northern and eastern portions of the county, water percolates rapidly through the ground surface and fills openings in the limestone layers. During wet seasons, the limestones become saturated and large quantities of water are available locally. However, between rains, the water rapidly drains from the limestone layers and shallow wells become dry. Some deep wells in the upland limestone area in the eastern part of the county provide sufficient water for domestic use even during dry weather. Additionally, in the central portion of the county, the solution channels in the limestones of Devonian Age apparently are more well developed and possibly the limestones are recharged directly from the Ohio River at the Falls of the Ohio. As a result, deep wells in the limestones in the central portion of the city provide supplies of as much as 1,000 gpm (gallons per minute). The water from the limestones in the area is highly mineralized. However, the concentrations of individual minerals vary significantly from place to place. In general, the water is a calcium bicarbonate groundwater. The average hardness of the water taken from wells in the limestone is 550 to 600 ppm (parts per million). The maximum hardness obtained from samples taken from wells in 1953 (a major study year) was 1,140 ppm. The total dissolved solids in water taken from wells in the limestone generally is in access of 1,200 ppm. The concentration of calcium, bicarbonate, and sulfate generally is high in waters taken from these wells.

The Pleistocene sand and gravels above the bedrock in the Jefferson County area form a much more reliable supply of water than the limestones which underlie the area. The shales found in the western portion of Jefferson County possess no value as sources of groundwater, but form a relatively impermeable bottom beneath the sand and gravel layers. The glacial sand and gravel is recharged naturally by rainfall which infiltrates through upper soil layers, by water infiltrating through the bottom and sides of the river channel, and by flow from the bedrocks which form the sides and bottom of the valley cut by the river during the glacial epoch. The permeability of the sand and gravel materials varies considerably from point to point because of the stratified nature of these deposits. However, the average porosity of the sand and gravel layers is in excess of 40% (Reference F-5), and permeability consequently is high. Because of the high porosity of the glacial sand and gravel deposit in the floodplain of the Ohio River, it has a vast water storage capacity and has a high transmissibility (see below). Because of these characteristics, the sand and gravel is a much more important aquifer than the underlying bedrock. Figure F.2 shows the location of the Louisville Gas & Electric Company Cane Run Plant and shows the locations of wells in the vicinity of the plant. Also in this figure, the quality of the water sampled from several of the wells in the vicinity is shown graphically. Figure F.3 shows the general geologic situation in the area and illustrates the control of groundwater flow exerted by the bedrock units.

Previous investigations into the quantity and quality of water available from soil and bedrock units in the Louisville area indicate that more than 280 million gallons per day of water of suitable quality for domestic and industrial uses could be obtained as a result of infiltration from the Ohio River into the sand and gravel aquifer beneath Jefferson County. An evaluation of the available groundwater southwest of Louisville during the period 1944-46 indicated the storage in the sand and gravel aquifer to be equivalent to approximately 1.5 billion gallons of water per foot of depth below the water table. At that time, infiltration was estimated in the southwestern Louisville area at approximately 11 million gallons per day, and flow into the sand and gravel aquifer from bedrock sources to the east was estimated at about 1 million gallons per day. Natural discharge from the sand and gravel aquifer to the river in this area was estimated at about 800,000 gallons per day per mile along the river.

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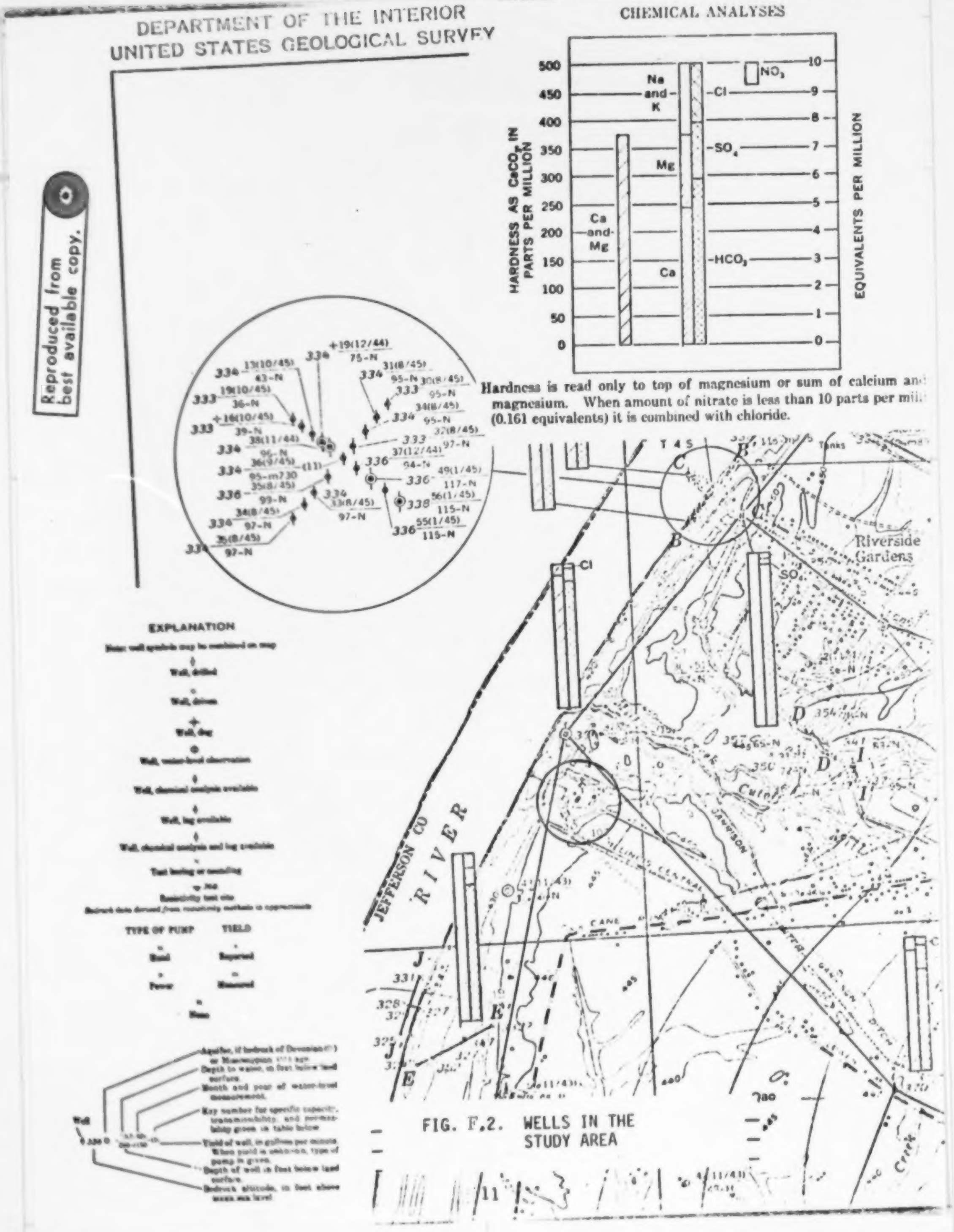
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
CHEMICAL ANALYSES
HARDNESS AS CaCO$_3$ IN PARTS PER MILLION
EQUIVALENTS PER MILLION
0
50
100
150
200
250
300
350
400
450
500
Ca and Mg
Na and K
Mg
Ca
Cl
SO$_4$
HCO$_3$
NO$_3$
EXPLANATION
Note: well symbols may be combined on map
Well, drilled
Well, driven
Well, dug
Well, water-level observation
Well, chemical analysis available
Well, log available
Well, chemical analysis and log available
Test boring or sounding
Resistivity test site
Bedrock data derived from resistivity methods is approximate
TYPE OF PUMP
YIELD
Hand
Reported
Power
Measured
None
Well
Aquifer, if bedrock of Devonian(?) or Mississippian (?) age
Depth to water, in feet below land surface
Month and year of water-level measurement
Key number for specific capacity, transmissibility, and permeability given in table below
Yield of well, in gallons per minute. When yield is unknown, type of pump is given
Depth of well in feet below land surface
Bedrock altitude, in feet above mean sea level
JEFFERSON CO
RIVER
Riverside Gardens
Tanks
T 4 S
CANE
Creek
B
C
D
E
I
J

Hardness is read only to top of magnesium or sum of calcium an magnesium. When amount of nitrate is less than 10 parts per mil (0.161 equivalents) it is combined with chloride.

FIG. F.2. WELLS IN THE STUDY AREA

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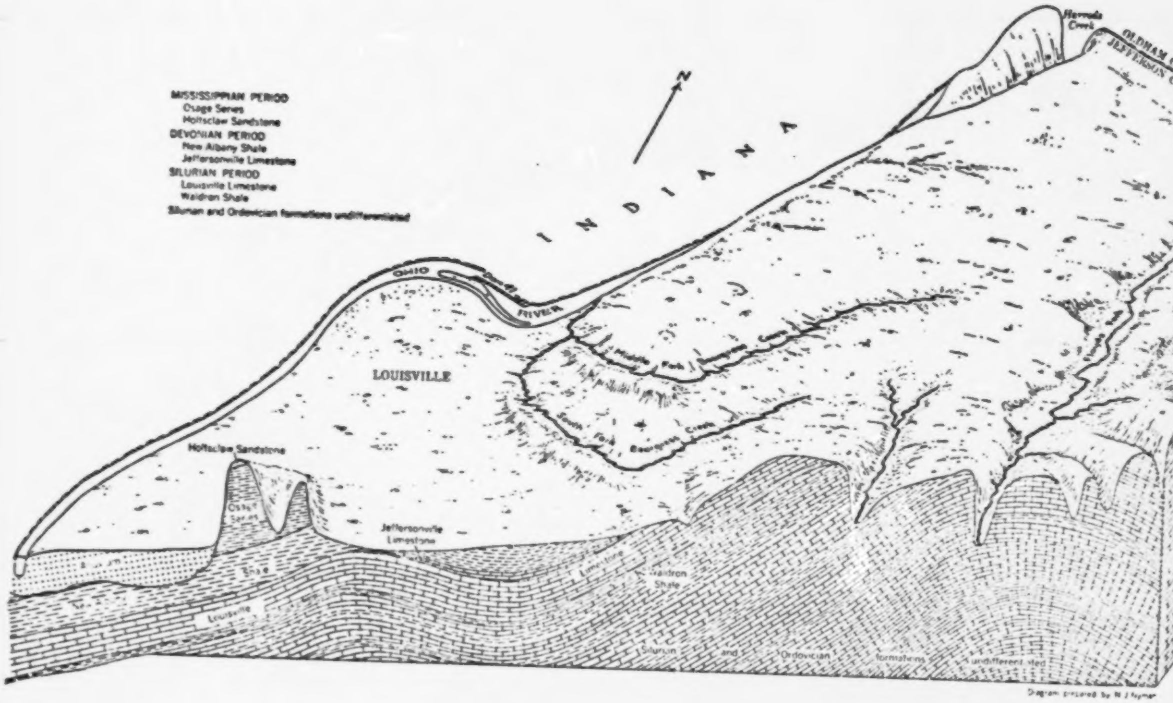
MISSISSIPPIAN PERIOD
Osage Series
Holtsclaw Sandstone
DEVONIAN PERIOD
New Albany Shale
Jeffersonville Limestone
SILURIAN PERIOD
Louisville Limestone
Waldron Shale
Silurian and Ordovician formations undifferentiated
N
INDIANA
Harrods Creek
OLDHAM CO
JEFFERSON CO
OHIO RIVER
LOUISVILLE
South Fork Beargrass Creek
Holtsclaw Sandstone
Osage Series
Jeffersonville Limestone
Shale
Limestone
Waldron Shale
Louisville
Silurian and Ordovician formations undifferentiated
Diagram prepared by R. J. Feymer

FIG. F.3. BLOCK DIAGRAM-
AREA GEOLOGY

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Figure F.4 shows the location of wells in the immediate vicinity of the Louisville Gas & Electric Company Plant. Figure F.5 shows lines of equal thickness of saturated sand and gravel in the area around the Louisville Gas & Electric Company Plant, in December 1955. Figure F.6 shows lines of equal thickness of saturated sand and gravel beneath the floodplain in the area of the plant in December, 1962. The information in these figures is of interest since considerable concern had been shown for the depletion of groundwater supplies when heavy pumping by industry during World War II had lowered the groundwater level by as much as 60 feet in the area around the distilleries in southwestern Louisville (in 1944). Additionally, increased use of groundwater for cooling in buildings in downtown Louisville had depressed the water level in that area by as much as 65 feet by 1955. At the locations where this pumping was taking place, the groundwater table had been drawn down to an elevation only 10 to 15 feet above the level of the underlying bedrock. Record lows were observed in wells in the Rubbertown industrial area in 1945. Figures F.7A, F.7B, F.7C, F.7D and F.7E show the periodic changes in water level in the southwestern Jefferson County area from 1948 to 1962. Water level contours are shown for 1948, 1952, and 1955 in Figures F.7A, F.7B, and F.7C, respectively. Net water level changes are shown in Figure F.7D. The water level contours in Figure F.7E correspond to data obtained in 1962. In general, the effects of this pumping indicate that sustained industrial or commerical pumping could significantly depress the water table around the vicinity of such pumping. Pumping in the Rubbertown area and in central Louisville may have slightly depressed the groundwater table in the area of the Louisville Gas & Electric Company Plant, but recovery would be rapid if pumping ceased.

Groundwater Flow

As mentioned previously, the sand and gravel aquifer underlying southwestern Jefferson County is generally quite pervious. The degree of perviousness

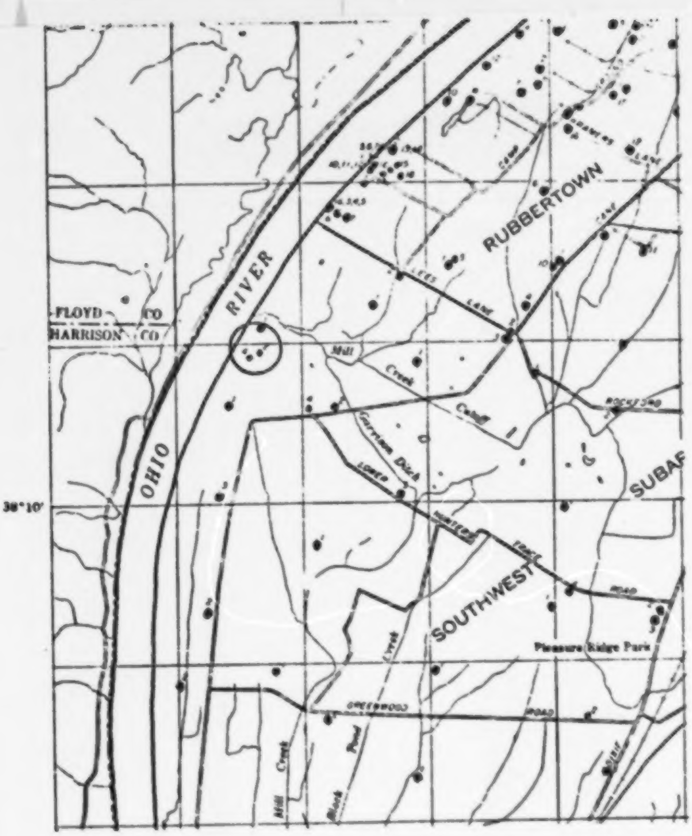
FLOYD CO
HARRISON CO
OHIO RIVER
RUBBERTOWN
LEES LANE
Mill Creek Cutoff
Garrison Ditch
LOWER HUNTERS TRACE
ROCKFORD
38°10'
SUBAR
SOUTHWEST
Pleasure Ridge Park
GREENWOOD ROAD
Mill Creek
Black Pond Creek

FIG. F.4. WELLS NEAR LG&E SITE

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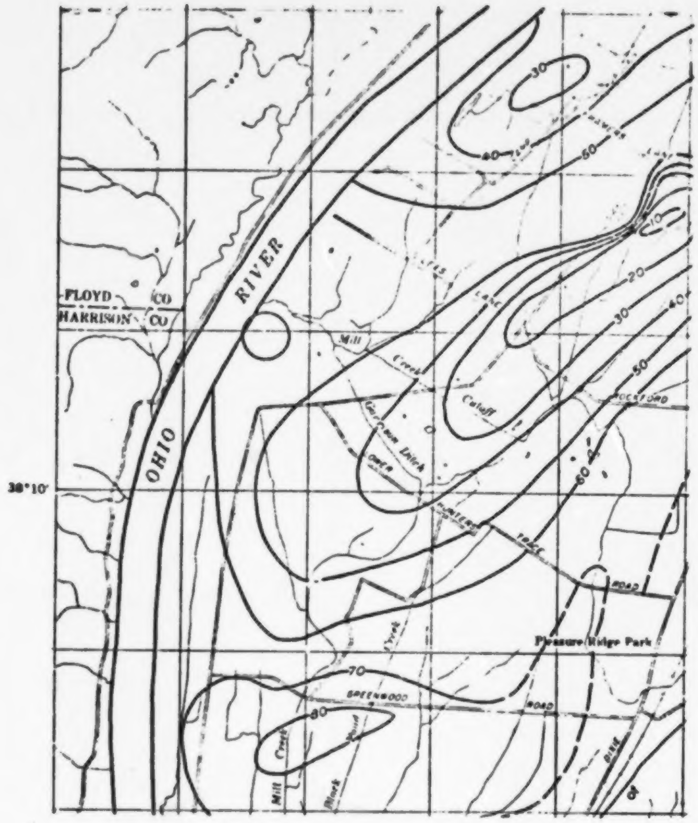
30
40
50
10
20
30
40
50
60
70
80
FLOYD CO
HARRISON CO
OHIO
RIVER
Mill Creek
Cutoff
Pleasure Ridge Park
GREENWOOD ROAD
ROCKFORD
DIXIE
Mill Creek
Black Pond Creek
38°10'

FIG. F.5. LINES OF EQUAL THICKNESS OF SAND-GRAVEL BODY

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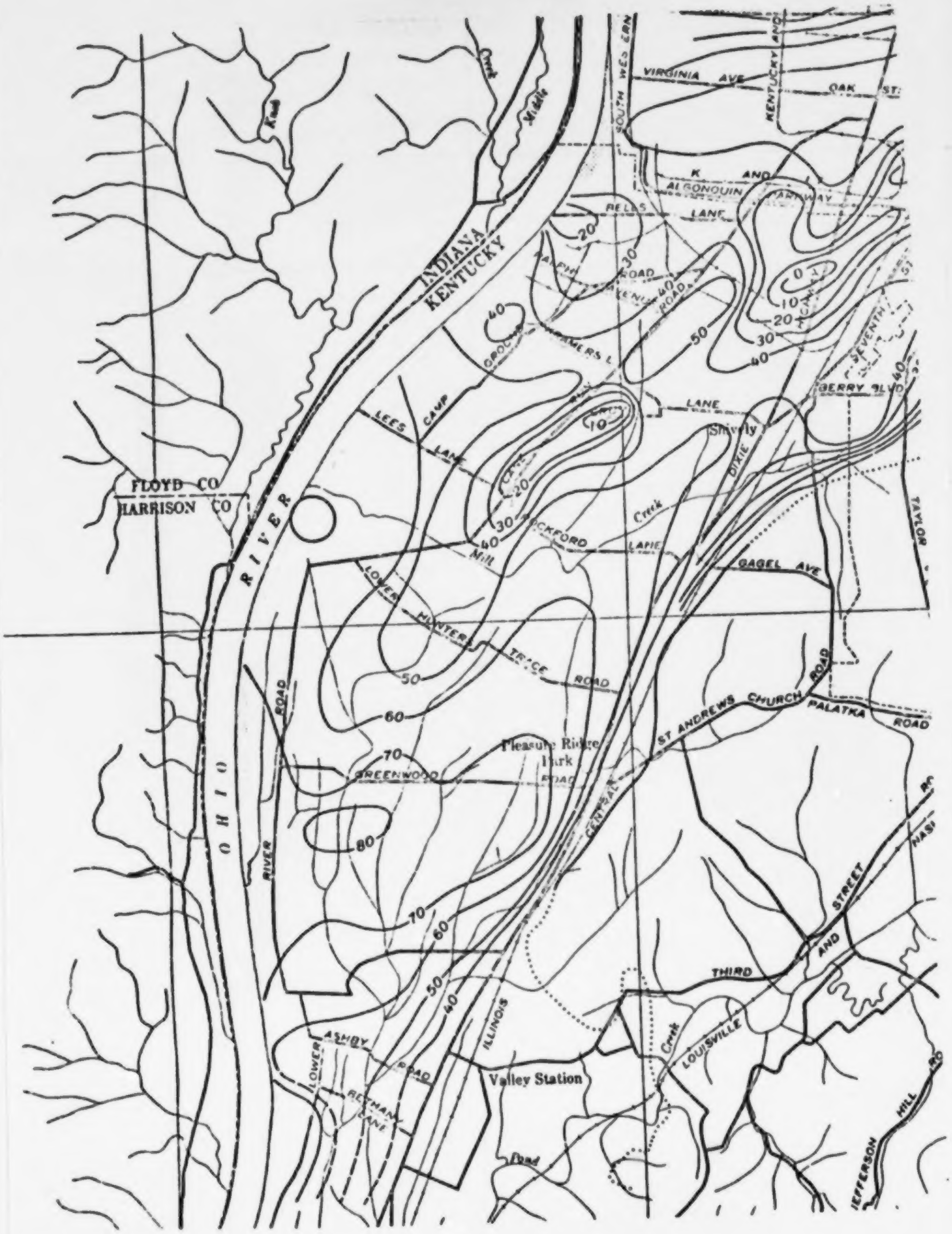
INDIANA
KENTUCKY
OHIO RIVER
FLOYD CO
HARRISON CO
Knob Creek
Middle Creek
SOUTH WESTERN
VIRGINIA AVE
KENTUCKY AND
OAK ST
ALGONQUIN PARKWAY
BELLS LANE
RALPH ROAD
CAMP GROUND ROAD
FARMERS L
LEES LANE
LANE
Shively
DIXIE
SEVENTH
BERRY BLVD
TAYLOR
Mill Creek
ROCKFORD LANE
GAGEL AVE
LOWER HUNTERS TRACE ROAD
RIVER ROAD
ST ANDREWS CHURCH ROAD
PALATKA ROAD
Pleasure Ridge Park
GREENWOOD ROAD
CENTRAL
ILLINOIS
THIRD
STREET AND
LOUISVILLE
Valley Station
LOWER ASHBY ROAD
BETHANY LANE
JEFFERSON HILL ROAD
Pond Creek
0
10
20
30
40
50
60
70
80

FIG. F.6. THICKNESS OF SATURATED SAND-GRAVEL (1962)

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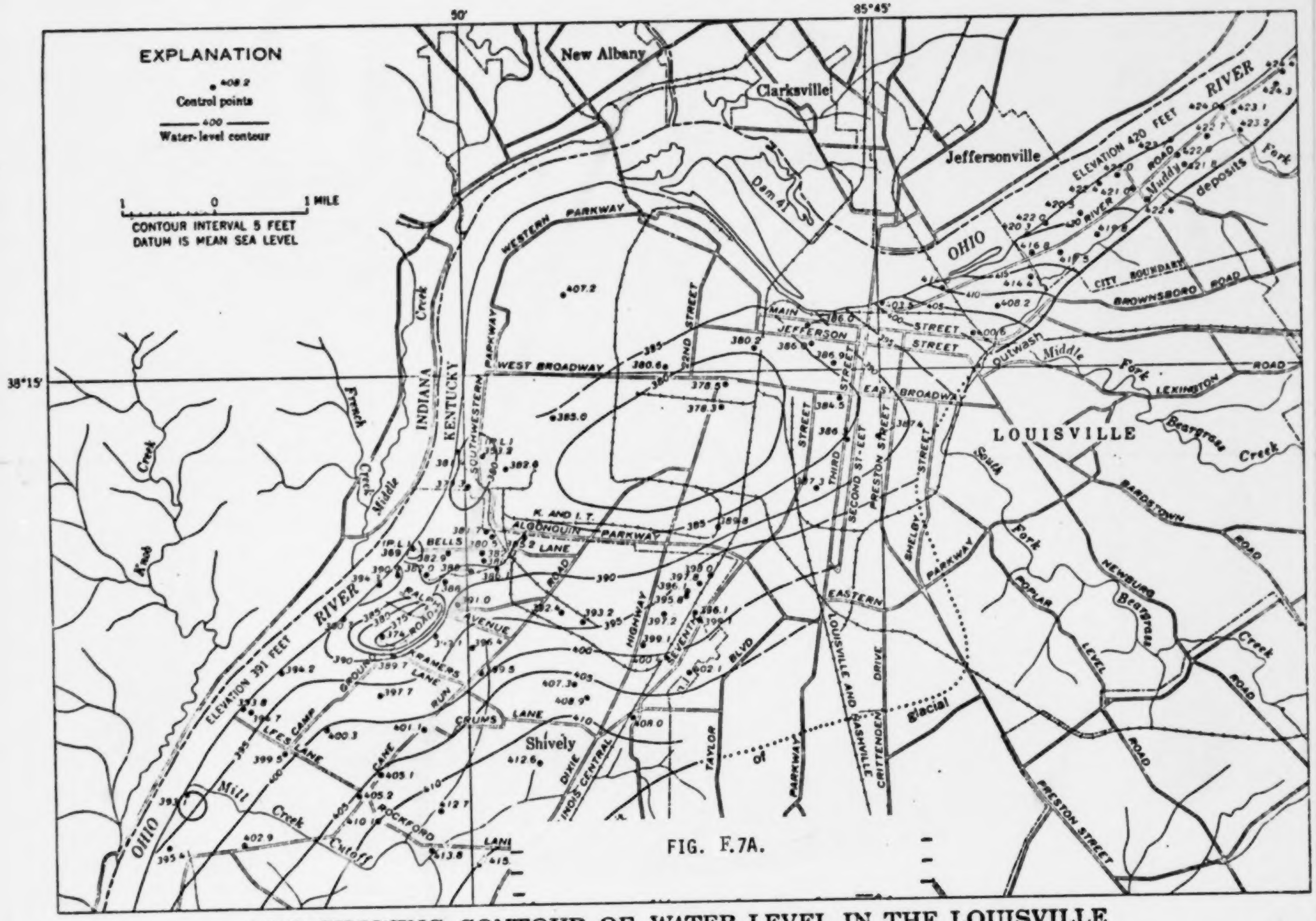
EXPLANATION
408.2 Control points
400 Water-level contour
1 0 1 MILE
CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL
50'
85°45'
38°15'
New Albany
Clarksville
Jeffersonville
Dam 41
OHIO RIVER
ELEVATION 420 FEET
ELEVATION 391 FEET
INDIANA
KENTUCKY
LOUISVILLE
Shively
French Creek
Middle Creek
Knob Creek
Mill Creek Cutoff
Middle Fork
South Fork
Beargrass Creek
Muddy Fork
Outwash
deposits
Glacial
CITY BOUNDARY
BROWNSBORO ROAD
LEXINGTON ROAD
BARDSTOWN ROAD
NEWBURG ROAD
POPLAR LEVEL ROAD
PRESTON STREET
RIVER ROAD
MAIN STREET
JEFFERSON STREET
WEST BROADWAY
EAST BROADWAY
22ND STREET
THIRD STREET
SECOND STREET
SHELBY STREET
EASTERN PARKWAY
CRITTENDEN DRIVE
LOUISVILLE AND NASHVILLE
TAYLOR BLVD
SEVENTH
HIGHWAY
DIXIE
ILLINOIS CENTRAL
WESTERN PARKWAY
SOUTHWESTERN PARKWAY
ALGONQUIN PARKWAY
K. AND I. T.
BELLS LANE
RALPH AVENUE
GRADE ROAD
KRAMERS LANE
GROUND
CRUMS LANE
CAMP
LEES LANE
ROCKFORD LANE
407.2
385.0
380.6
378.5
378.3
380.2
386.0
386.9
386
387.3
389.8
393.2
395
390
400
405
410
415
402.9
395.4
399.5
400.3
401.1
405.1
405.2
412.7
413.8
412.6
408.0
407.3
408.9
422.0
423.1
423.3
424.3
408.2
400.5

FIG. F.7A.

MAP SHOWING CONTOUR OF WATER LEVEL IN THE LOUISVILLE AREA, KENTUCKY, DECEMBER 1948

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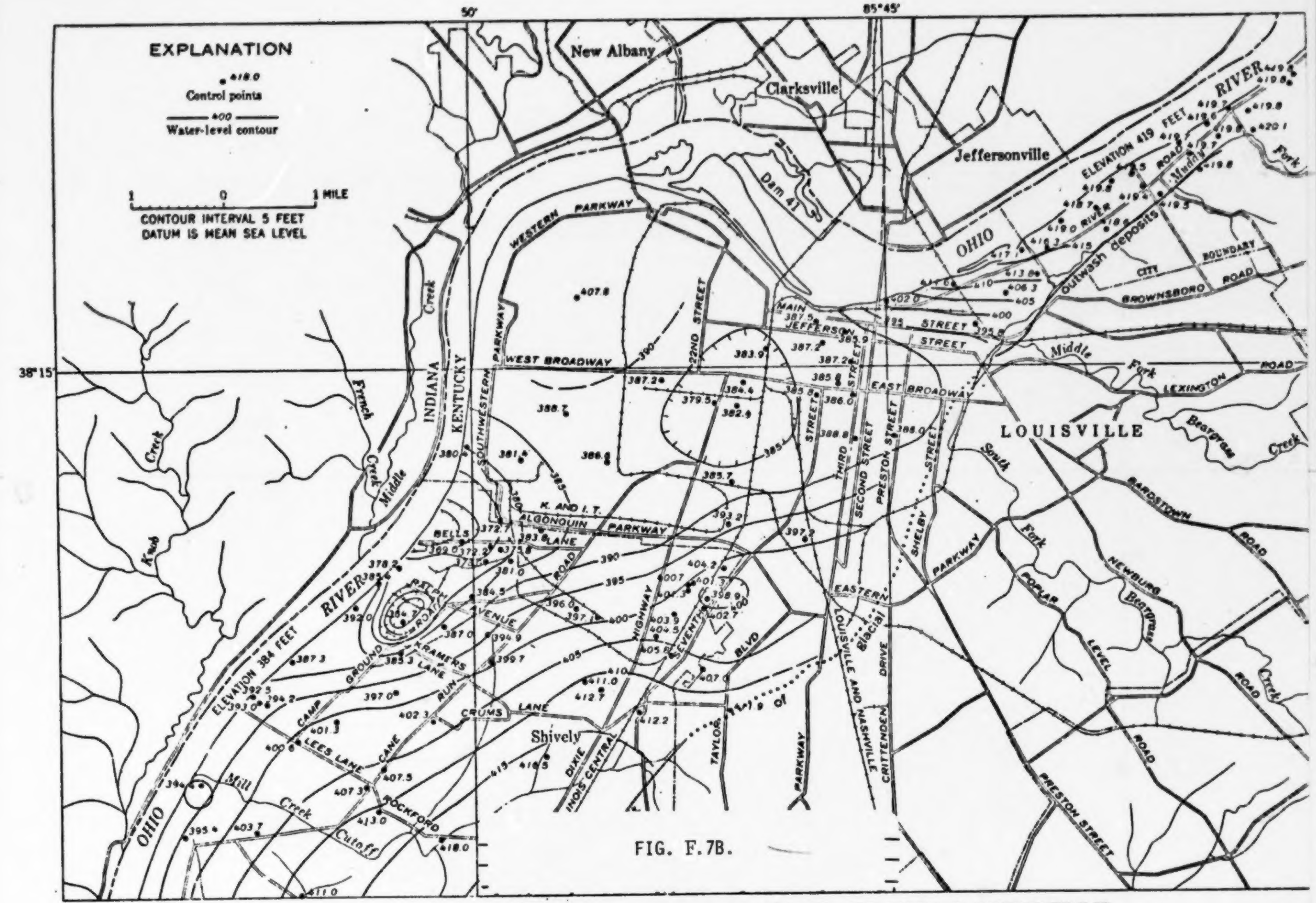
EXPLANATION
418.0
Control points
400
Water-level contour
1 0 1 MILE
CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL
50'
85°45'
38°15'
New Albany
Clarksville
Jeffersonville
Dam 41
OHIO RIVER
ELEVATION 419 FEET
ELEVATION 384 FEET
Outwash deposits
LOUISVILLE
INDIANA
KENTUCKY
Shively
WESTERN PARKWAY
SOUTHWESTERN PARKWAY
WEST BROADWAY
EAST BROADWAY
22ND STREET
MAIN
JEFFERSON STREET
THIRD STREET
SECOND STREET
PRESTON STREET
SHELBY STREET
CITY BOUNDARY
BROWNSBORO ROAD
LEXINGTON ROAD
BARDSTOWN ROAD
NEWBURG ROAD
POPLAR LEVEL ROAD
PRESTON STREET
EASTERN PARKWAY
K. AND I. T.
ALGONQUIN PARKWAY
BELLS LANE
RALPH AVENUE
KRAMERS LANE
GROUND ROAD
CAMP GROUND ROAD
RUN
CRUMS LANE
LEES LANE
CANE RUN
ROCKFORD
DIXIE
ILLINOIS CENTRAL
HIGHWAY
SEVENTH ST.
TAYLOR BLVD
LOUISVILLE AND NASHVILLE
CRITTENDEN DRIVE
PARKWAY
Limit of Glacial
French Creek
Middle Creek
Knob Creek
Mill Creek Cutoff
Middle Fork
South Fork
Beargrass Creek
Muddy Fork

FIG. F.7B.

MAP SHOWING CONTOUR OF WATER LEVEL IN THE LOUISVILLE AREA, KENTUCKY, DECEMBER 1952

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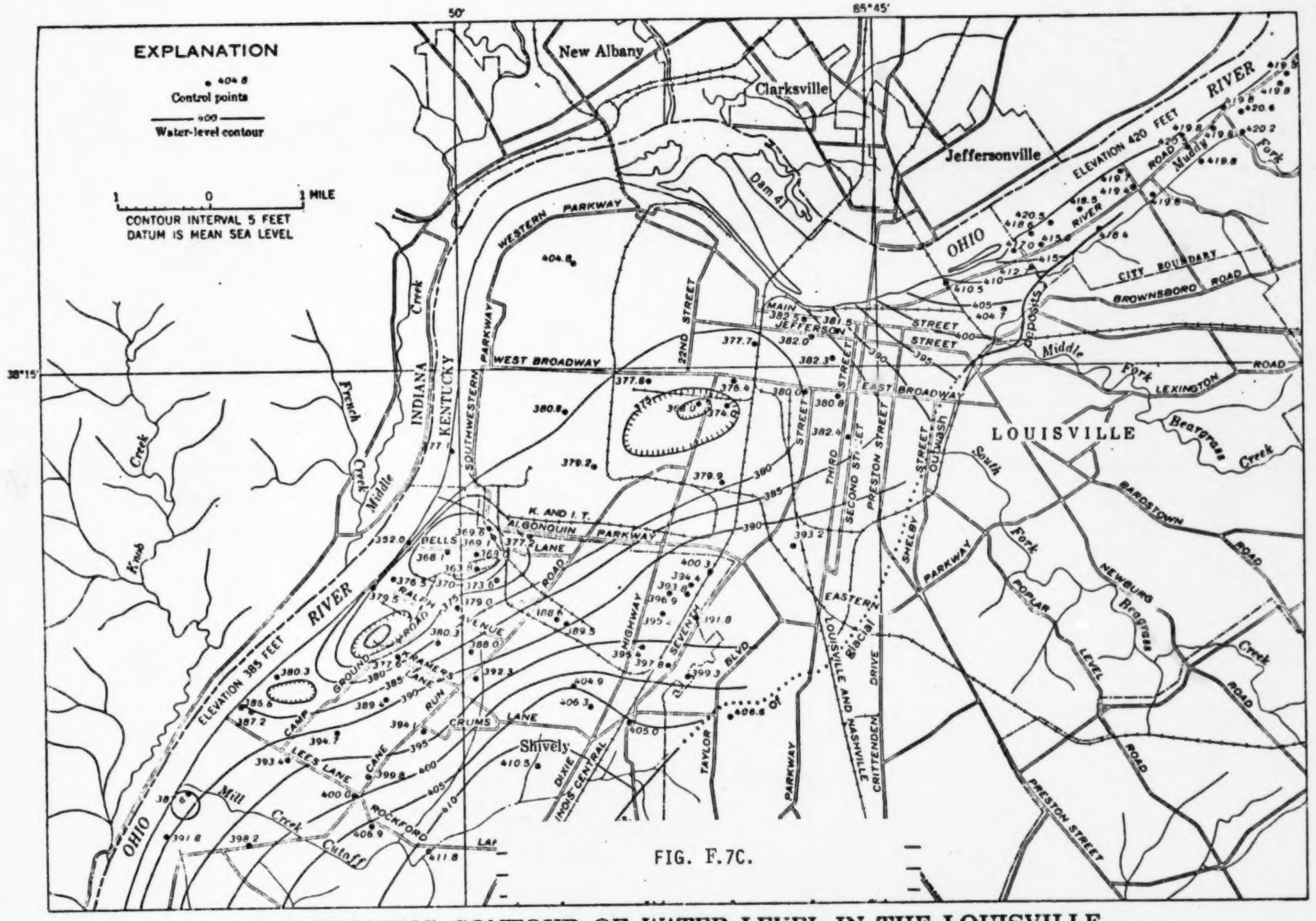
EXPLANATION
404.8 Control points
400 Water-level contour
1 0 1 MILE
CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL
50'
85°45'
38°15'
New Albany
Clarksville
Jeffersonville
Dam 41
OHIO RIVER
ELEVATION 420 FEET
ELEVATION 385 FEET
INDIANA
KENTUCKY
LOUISVILLE
Shively
WESTERN PARKWAY
SOUTHWESTERN PARKWAY
WEST BROADWAY
EAST BROADWAY
22ND STREET
MAIN STREET
JEFFERSON STREET
THIRD STREET
SECOND STREET
PRESTON STREET
SHELBY STREET
CITY BOUNDARY
BROWNSBORO ROAD
LEXINGTON ROAD
BARDSTOWN ROAD
NEWBURG ROAD
POPLAR LEVEL ROAD
PRESTON STREET
ALGONQUIN PARKWAY
K. AND I. T.
DIXIE HIGHWAY
SEVENTH ST
TAYLOR BLVD
CRUMS LANE
LEES LANE
CANE RUN
CAMP GROUND ROAD
RALPH AVENUE
KRAMERS LANE
BELLS LANE
ROCKFORD LANE
LOUISVILLE AND NASHVILLE
ILLINOIS CENTRAL
CRITTENDEN DRIVE
EASTERN PARKWAY
Muddy Fork
Middle Fork
South Fork
Beargrass Creek
French Creek
Middle Creek
Knob Creek
Mill Creek Cutoff
Glacial

FIG. F.7C.

MAP SHOWING CONTOUR OF WATER LEVEL IN THE LOUISVILLE AREA, KENTUCKY, DECEMBER 1955

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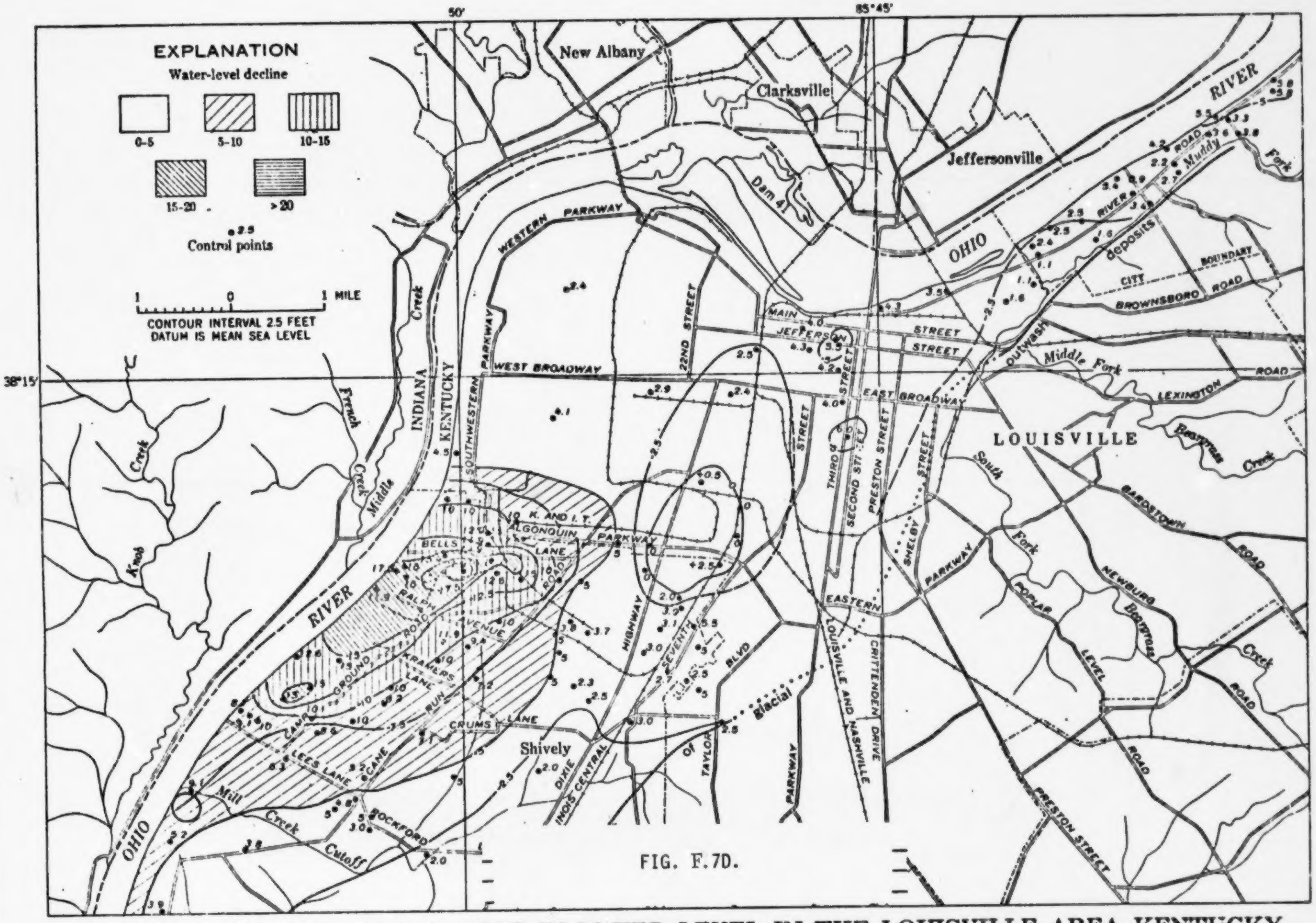
EXPLANATION
Water-level decline
0-5
5-10
10-15
15-20
>20
Control points
CONTOUR INTERVAL 2.5 FEET
DATUM IS MEAN SEA LEVEL
1 MILE
50'
85°45'
38°15'
New Albany
Clarksville
Jeffersonville
Dam 41
OHIO RIVER
INDIANA
KENTUCKY
LOUISVILLE
Shively
WESTERN PARKWAY
SOUTHWESTERN PARKWAY
WEST BROADWAY
EAST BROADWAY
22ND STREET
MAIN
JEFFERSON
STREET
THIRD
SECOND STREET
PRESTON STREET
SHELBY
PARKWAY
EASTERN
CRITTENDEN DRIVE
LOUISVILLE AND NASHVILLE
ILLINOIS CENTRAL
DIXIE HIGHWAY
SEVENTH
TAYLOR BLVD
Glacial
ALGONQUIN PARKWAY
K. AND I. T.
BELLS LANE
RALPH AVENUE
GROUND ROAD
KRAMERS LANE
RUN
CRUMS LANE
LEES LANE
CANE
ROCKFORD
Mill Creek Cutoff
French Creek
Middle Creek
Knob Creek
Muddy Fork
RIVER ROAD
deposits
CITY BOUNDARY
BROWNSBORO ROAD
OUTWASH
Middle Fork
Beargrass Creek
LEXINGTON ROAD
South Fork
BARDSTOWN ROAD
NEWBURG ROAD
POPLAR LEVEL ROAD
PRESTON STREET

FIG. F.7D.

MAP SHOWING THE NET CHANGE IN WATER LEVEL IN THE LOUISVILLE AREA, KENTUCKY, DECEMBER 1948 TO DECEMBER 1955

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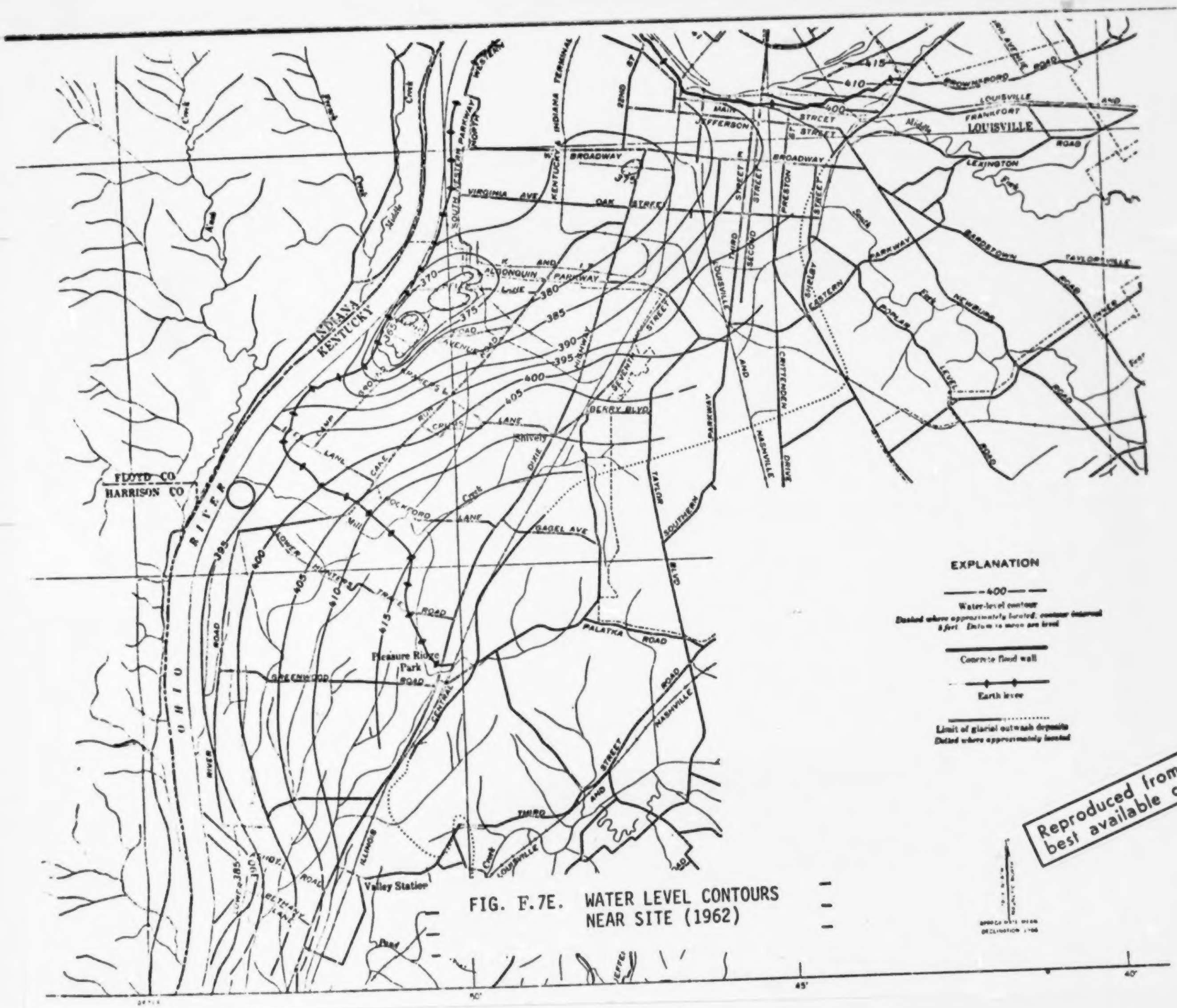
LOUISVILLE
INDIANA
KENTUCKY
FLOYD CO.
HARRISON CO.
OHIO RIVER
BROADWAY
VIRGINIA AVE
OAK STREET
ALGONQUIN PARKWAY
TAYLOR BLVD
BERRY BLVD
DIXIE HIGHWAY
SEVENTH STREET
CRITTENDEN DRIVE
PRESTON STREET
SHELBY STREET
EASTERN PARKWAY
BARDSTOWN ROAD
TAYLORSVILLE ROAD
POPLAR LEVEL ROAD
NEWBURG ROAD
LEXINGTON ROAD
FRANKFORT
BROWNSBORO ROAD
MAIN STREET
JEFFERSON STREET
LOUISVILLE AND NASHVILLE
THIRD STREET
SECOND STREET
KENTUCKY & INDIANA TERMINAL
SOUTH WESTERN PARKWAY
Shively
ROCKFORD LANE
GAGEL AVE
LOWER HUNTERS TRACE ROAD
PALATKA ROAD
GREENWOOD ROAD
Pleasure Ridge Park
Valley Station
370
375
380
385
390
395
400
405
410
415
EXPLANATION
—400—
Water-level contour
Dashed where approximately located; contour interval 5 feet. Datum is mean sea level
Concrete flood wall
Earth levee
Limit of glacial outwash deposits
Dotted where approximately located

FIG. F.7E. WATER LEVEL CONTOURS NEAR SITE (1962)

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usually is expressed by a coefficient known as the permeability coefficient. This is the rate of water flow, in gallons per day, through a 1-foot-square cross-section of stratum (aquifer) under standard conditions (consisting of a unit hydraulic gradient). The total capability of an aquifer to transmit water is measured by a parameter called the transmissibility, a measure of the capacity of the full thickness of an aquifer to transmit at the prevailing water temperature. This parameter generally is based upon an assumption that the aquifer is composed of uniform-sized material throughout its entire thickness; in other words, flow is assumed to be uniform across the entire thickness of the aquifer. Transmissibilities have been measured in pumping tests in Jefferson County in the vicinity of the Can Run Plant site. These transmissibilities, given in Reference F-5 are based on the results of two full scale pumping tests. In these tests the maximum transmissibility measured was 45,000 gallons per day per foot of aquifer, and the minimum value was 20,000 gallons per day per foot of aquifer. These values indicate that, in general, the sand and gravel aquifer would be in excellent source of groundwater on a permanent basis if a sufficient connection exists between this aquifer and a permanent water supply such as the Ohio River.

The Ohio River is connected hydraulically with the sand and gravel aquifer along most of the riverbank in the Jefferson County area. However, the degree of effectiveness of this connection varies considerably. The best connection, which would give the greatest infiltration of water from the river into the aquifer, is indicated in the area in the northeastern portion of the county, northeast of Zorn Avenue. The hydraulic connection between the aquifer and the river is less effective, because of the presence of clay barriers, in the length of stream between Zorn Avenue and McAlpine Dam. These clay barriers have formed through the collapse of upper layers of silty clay and clay deposited during periods of flooding by the river during the latter stages of the glacial epoch and during Recent times. In the stretch of river between McAlpine Dam and Bells Lane, the connection is poor. However, southward from Bells Lane toward the southwestern portion of the county (toward Kosmosdale) the connection between the river and the aquifer is excellent. The good connection between the aquifer and the river in this area is indicated by the slight influence on water levels produced by extensive pumping, as shown in Figure F.7A-E.

The sand and gravel aquifer in the river valley is recharged naturally by flow through the upper layers of alluvium consisting of silt and clay, and by flow through the permeable rocks to the east and north of the aquifer. Thus, recharge occurs partly by direct downward infiltration and partly by indirect flow through the bedrock layers. The flow through the valley wall into the aquifer has been estimated in the southwestern portion of Louisville at approximately 100,000 gallons per day per mile of valley wall (Reference F-2). The flow laterally and upward through the limestone bedrock to the sand and gravel aquifer is much greater than any flow through the underlying shale materials. Natural flow by downward seepage through the alluvium is restricted in some areas by a considerable thickness of silt and clay above the sand and gravel; naturally, downward seepage is restricted in paved areas in the city. The variable quality of the connection between the Ohio River and the sand and gravel aquifer, and the variable covering of the aquifer by silt and clay deposits, is shown by hydrographs for wells throughout the area around the Louisville Gas & Electric Company Plant, Figures F.8A-F.8O. These hydrographs indicate the changes in water level in the wells with time. A relatively poor connection between the river and the aquifer and a relatively low degree of infiltration of surface water must be assumed for the wells corresponding to Figures F.8A, F.8B, F.8H, F.8I, and F.8J. A moderate connection could be assumed for the well corresponding to Figure F.8N. A good connection between the river and the

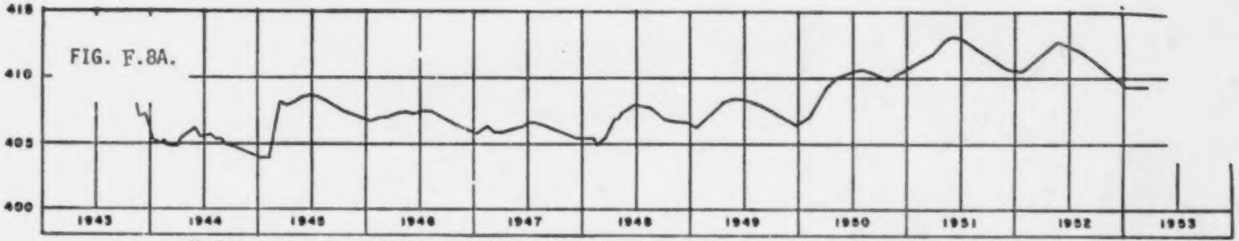

FIG. F.8A.

--Hydrograph of well N-1,530.2-230.6 (formerly 52-7-1) Johnsontown Road 1.5 miles west of Dixie Highway, Jefferson Co. Owner, Lanson Beahl. Dug, used well in glacial sand and gravel. Diameter 36.0 inches, depth 55.0 feet. LSD is 445.64 feet above msl.

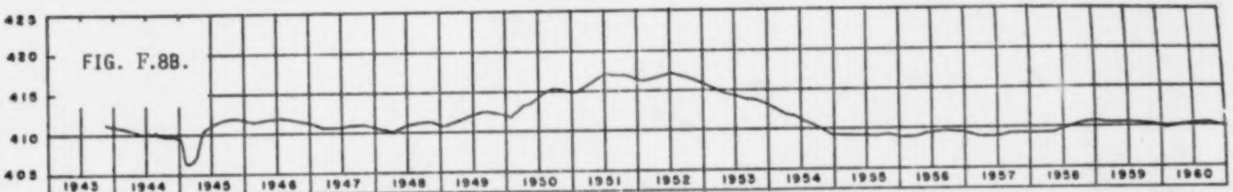

FIG. F.8B.

--Hydrograph of well N-1,534.5-236.3 (formerly 52-8-1) 0.5 mile south of Greenwood School, Jefferson Co. Owner, Mrs. Anna Dohn. Dug and driven unused well in glacial sand and gravel (Dug) diameter 30.0 inches, depth, 50.0 feet. (Driven) diameter 2.5 inches, depth 70.0 feet. LSD is 457.47 feet above msl.

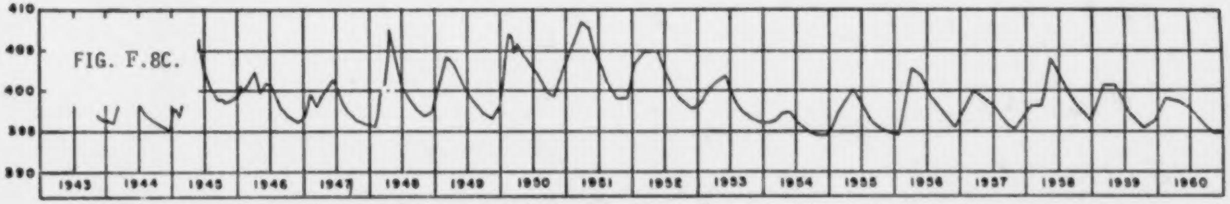

FIG. F.8C.

.--Hydrograph of well N-1,527.3-247.3 (formerly 53-10-3) Lower River Rd. 1.4 miles north of Greenwood Rd., Jefferson Co. Owner, Henry Huffluge. Dug, used well in glacial sand and gravel. Diameter 30.0 inches, depth 65.0 feet. LSD is 453.21 feet above msl.

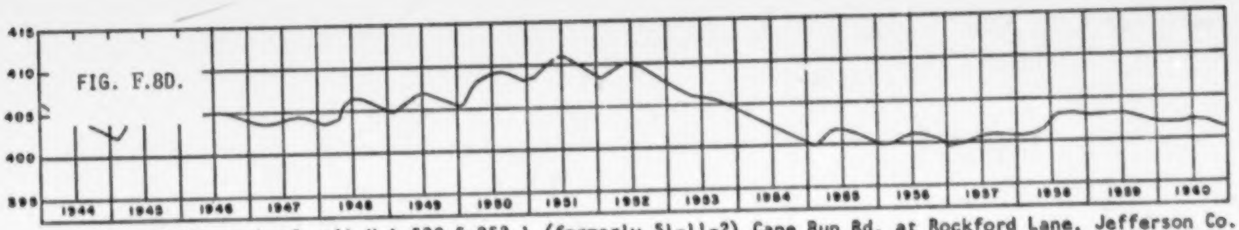

FIG. F.8D.

.--Hydrograph of well N-1,538.5-253.1 (formerly 51-11-2) Cane Run Rd. at Rockford Lane, Jefferson Co. Owner, Kaufman, Bros. Driven, unused well in glacial sand and gravel. Diameter 2.5 inches, depth 53.5 feet. LSD is 452.26 feet above msl.

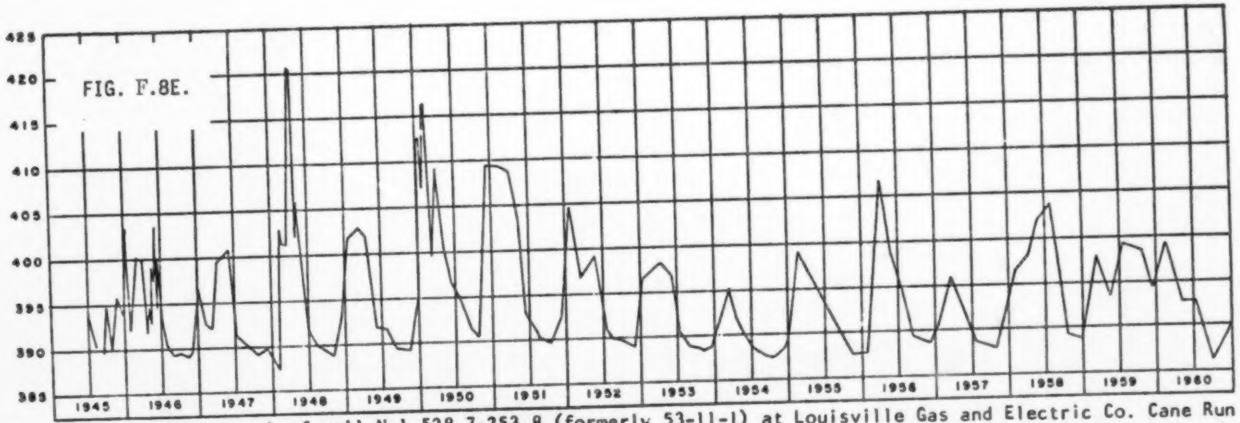

FIG. F.8E.

.--Hydrograph of well N-1,528.7-253.8 (formerly 53-11-1) at Louisville Gas and Electric Co. Cane Run Plant, Jefferson Co. Owner, Louisville Gas and Electric Co. Drilled observation well in glacial sand and gravel. Diameter 6.0 inches, depth 99.0 feet. LSD is 430.66 feet above msl.

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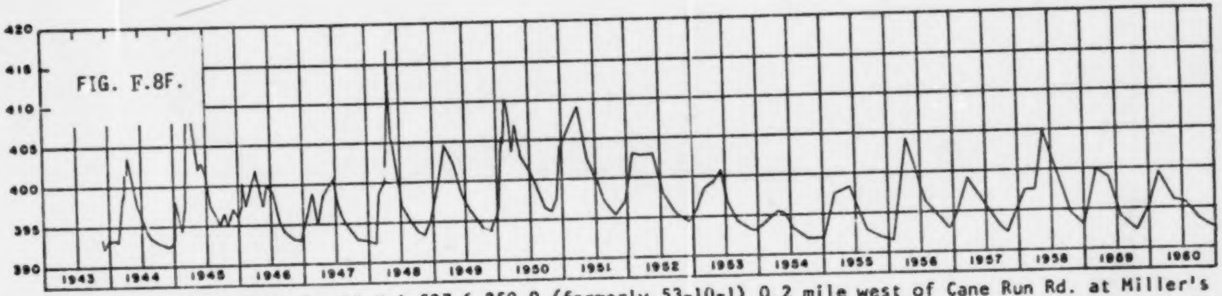


FIG. F.8F. --Hydrograph of well N-1,527.6-250.9 (formerly 53-10-1) 0.2 mile west of Cane Run Rd. at Miller's Apple Orchard, Jefferson Co. Owner, W. E. Miller. Dug and driven unused well in glacial sand and gravel. (Dug) diameter 48.0 inches, depth 47.0 feet. (Driven) diameter 2.0 inches, depth 56.0 feet. LSD is 438.72 feet above msl.

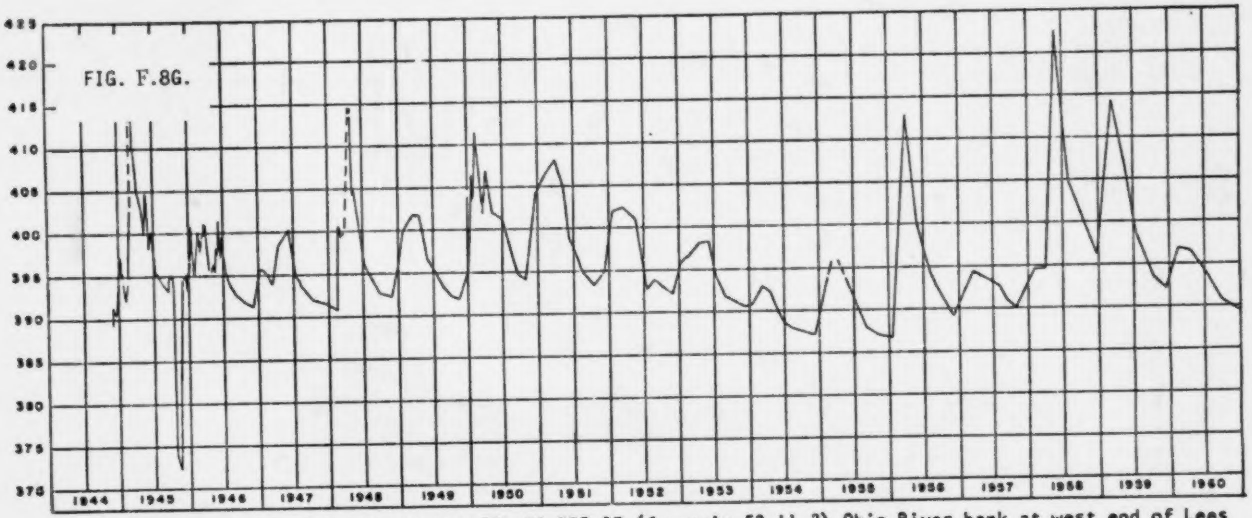
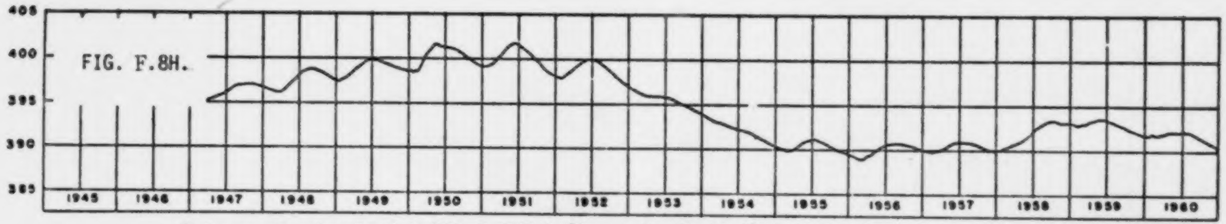


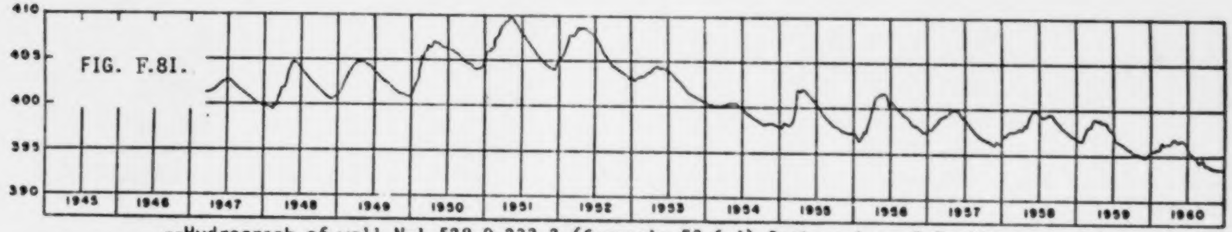
FIG. F.8G. --Hydrograph of well N-1,531.56-257.97 (formerly 52-11-3) Ohio River bank at west end of Lees Lane, Jefferson Co. Owner, Rubber Reserve Co. Drilled observation well in glacial sand and gravel. Diameter 6.0 inches, depth 96.2 feet. LSD is 428.45 feet above msl.

FIG. F.8H.



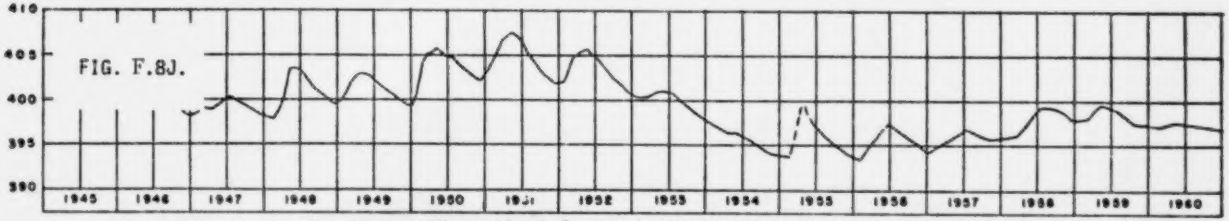
--Hydrograph of well N-1,540.0-258.6 (formerly 51-11-6) Schenks Lane 0.8 mile west of Cane Run Rd. Jefferson Co. Owner, Rubber Reserve Co. Drilled observation well in glacial sand and gravel. Diameter 6.0 inches, depth 112.1 feet. LSD is 446.27 feet above msl.

FIG. F.8I.



--Hydrograph of well N-1,528.9-223.3 (formerly 53-6-1) Bethany Lane 0.2 mile east of Lower River Rd., Jefferson Co. Owner, Rubber Reserve Co. Drilled observation well in glacial sand and gravel. Diameter 6.0 inches, depth 92.0 feet. LSD is 433.89 feet above msl.

FIG. F.8J.



--Hydrograph of well N-1,534.4-255.5 (formerly 52-11-21) Lees Lane and Camp Ground Rd., Jefferson Co. Owner, Rubber Reserve Co. Drilled observation well in glacial sand and gravel. Diameter 6.0 inches, depth 102.6 feet. LSD is 435.82 feet above msl.

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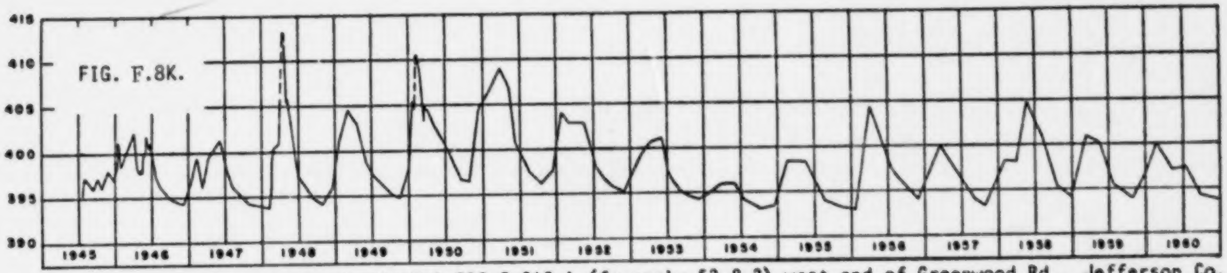
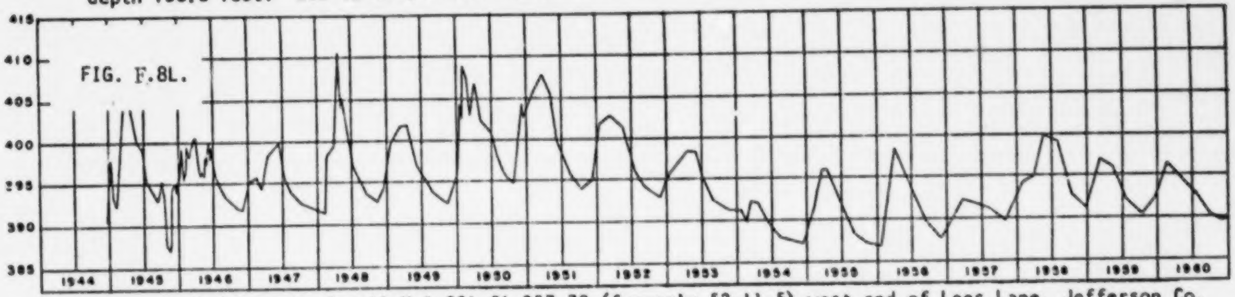
FIG. F.8K.



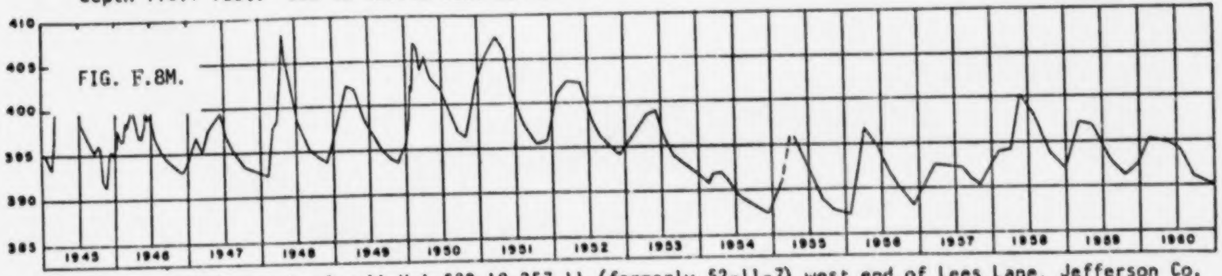
--Hydrograph of well N-1,525.5-240.1 (formerly 53-8-2) west end of Greenwood Rd., Jefferson Co. Owner, Rubber Reserve Co. Drilled observation well in glacial sand and gravel. Diameter 6.0 inches, depth 138.8 feet. LSD is 432.90 feet above msl.

FIG. F.8L.



--Hydrograph of well N-1,531.84-257.78 (formerly 52-11-5) west end of Lees Lane, Jefferson Co. Owner, Rubber Reserve Co. Drilled observation well in glacial sand and gravel. Diameter 6.0 inches, depth 116.7 feet. LSD is 450.40 feet above msl.

FIG. F.8M.



--Hydrograph of well N-1,532.10-257.11 (formerly 52-11-7) west end of Lees Lane, Jefferson Co. Owner, Rubber Reserve Co. Drilled observation well in glacial sand and gravel. Diameter 6.0 inches, depth 114.7 feet. LSD is 450.80 feet above msl.

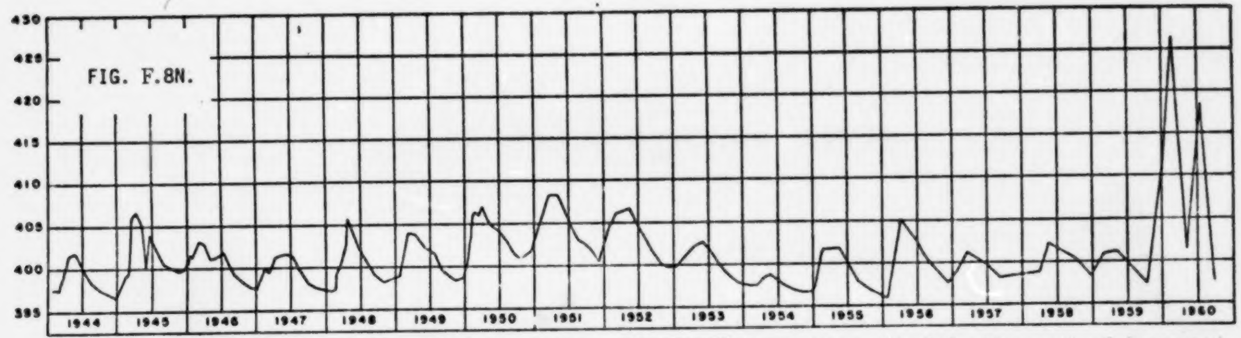


FIG. F.8N.--Hydrograph of well N-1,526.9-242.5 (formerly 53-9-2) Lower River Rd. 0.5 mile north of Greenwood Rd., Jefferson Co. Owner, Mrs. A. J. Seibert. Driven observation well in glacial sand and gravel. Diameter 2.0 inches, depth 52.0 feet. LSD is 444.32 feet above msl.

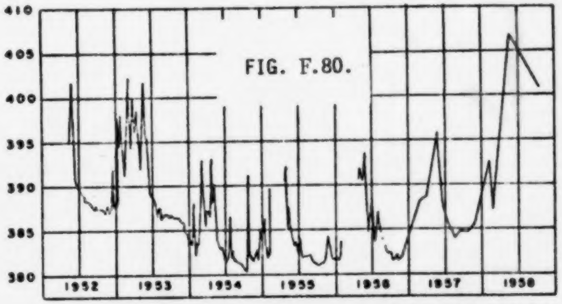


FIG. F.80.--Hydrograph of well N-1,531.79-258.20 (formerly 52-12-9) Ohio River bank at Stauffer Chemical Co. Plant, Jefferson Co. Owner, Stauffer Chemical Co. Drilled unused well in glacial sand and gravel. Diameter 6.0 inches, depth 95.6 feet. LSD is 403.05 feet above msl.

aquifer could be inferred for the wells corresponding to Figures F.8C, F.8E, F.8F, F.8K, F.8L, and F.8M. A very good connection would be inferred for the wells corresponding to Figures F.8G and F.8O. The hydrograph shown in Figure F.8E is of particular interest since it represents data for an observation well located at the Louisville Gas & Electric Company Cane Run Plant facility. It shows a peaking of water level in 1948 and a gradual average decline in water level since that period. Additionally, it shows fluctuations in the water level yearly, indicating a rather good connection between the aquifer and the river at this location.

Groundwater Quality

In general the quality of the groundwater in the Jefferson County area reflects the source of the water. Water obtained from the sand and gravel aquifer is generally very hard, is high in bicarbonate concentration, and contains dissolved solids ranging in concentration from 250 to more than 1,500 parts per million. The most highly mineralized water is found in the central and west-central parts of Jefferson County where the alluvium is underlain by limestone. Where the underlying bedrock is limestone, the hardness of the water is generally less than 500 ppm. Groundwater from the alluvium is not satisfactory for many purposes, especially industrial uses, unless it is softened. In general, wells near the Ohio River yield water with less hardness and lower dissolved solids content than those located in the remainder of the area. This effect, however, is generally noticeable only within about one quarter mile of the river.

Groundwater temperatures are fairly constant and generally correspond to the average air temperature. The groundwater temperature averages approximately 58°F, except where the aquifer shows a very good connection with the river, or where artificial recharge occurs from pumped wells or from leaking sewers. The overall range in temperature of water from wells in the Jefferson County area

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is from about 47^o to 66^oF. Temperatures of water taken from wells in the area of the Louisville Gas & Electric Company Plant is shown in Figure F.9A.

The chemical quality of the groundwater is shown generally in Figure F.2, and more particularly in Figure F.9B and F.9C. The dissolved solids content in wells underlain by shale, in samples of water taken in 1954, varied from 341 ppm to 858 ppm. The relative contribution of various ions in the groundwater was estimated at approximately 95% calcium and magnesium, with only 5% sodium and potassium for cation species. The anions consist principally of carbonate and bicarbonate ions (85%) with minor amounts of sulfate and chloride ions. In the water above the shale bedrock, sulfate ion concentrations range from about 14 to 63 equivalents per million. In the area of the plant site, iron content generally varies from 0.5 to 2.5 ppm. Chloride ion content generally is less than 20 ppm. Total hardness expressed as calcium carbonate varies from approximately 200 to 300 ppm. Specific conductance varies from approximately 400 to 600 micromhos.

Local Conditions

The information contained in the previous paragraphs can be combined with information obtained during site visits at the Louisville Gas & Electric Company Cane Run Plant to provide a picture of the overall hydrology of the plant site. An on-site exposure of the sand and gravel aquifer to depths of as much as 30 feet was available for inspection prior to the beginning of the demonstration of sludge disposal at the facility. An excavation was being made to furnish additional space for flyash disposal at the plant site at a location immediately south of the sludge disposal pools and pits. The project investigators closely examined this site and were able to determine that the silty clay and clay layers above the main aquifer constituted only the upper 8 to 10 feet of subsoils at the site. Beneath the upper layers of fine soil, the aquifer materials were found to be progressively coarser and larger in grain size. The sand and gravel

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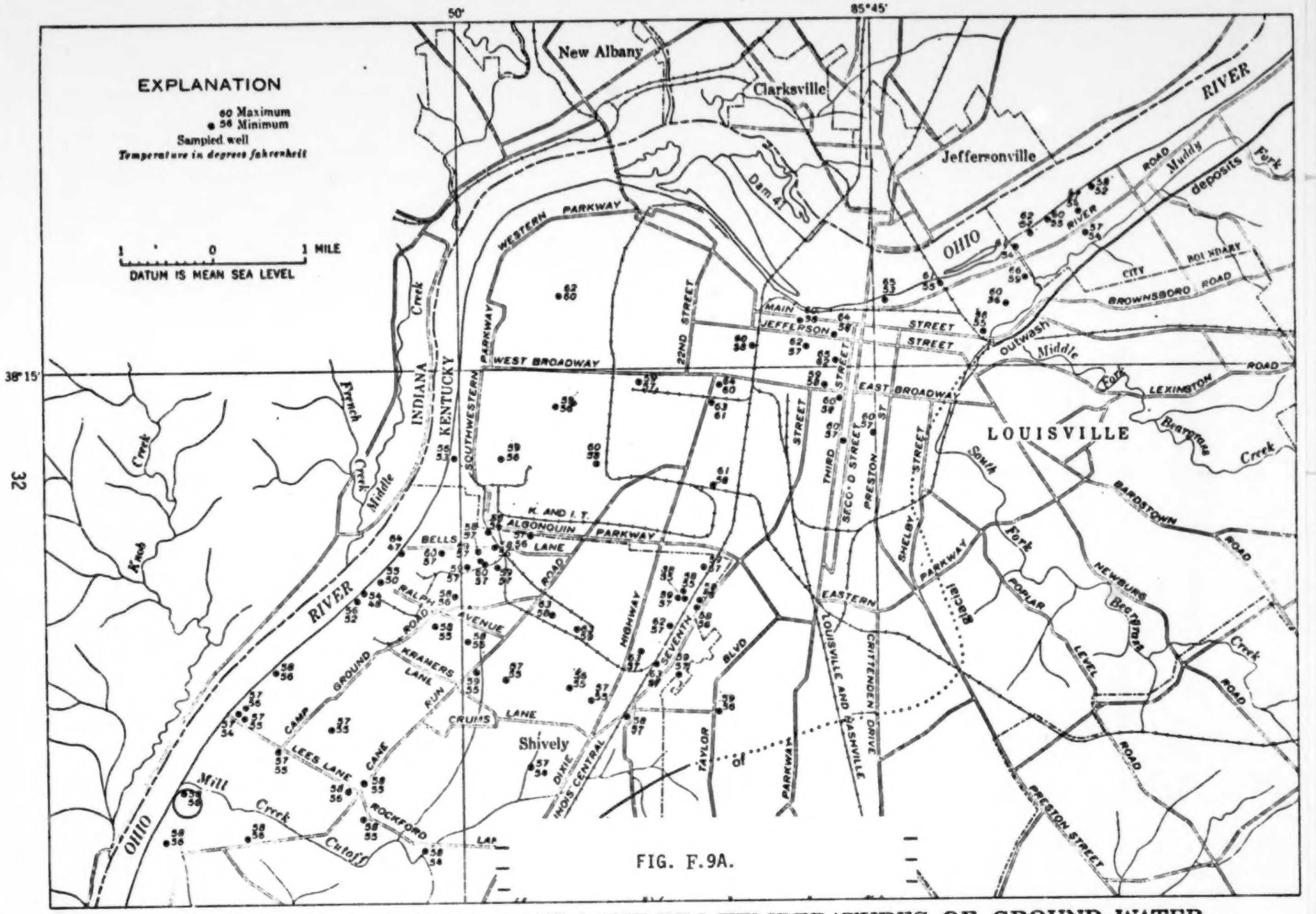
EXPLANATION
60 Maximum
56 Minimum
Sampled well
Temperature in degrees fahrenheit
1 0 1 MILE
DATUM IS MEAN SEA LEVEL
50'
85°45'
38°15'
New Albany
Clarksville
Jeffersonville
Dam 41
OHIO RIVER
INDIANA
KENTUCKY
LOUISVILLE
Shively
Muddy Fork
deposits
Outwash
Middle Fork
Beargrass Creek
South Fork
Glacial
French Creek
Middle Creek
Knob Creek
Mill Creek Cutoff
WESTERN PARKWAY
SOUTHWESTERN PARKWAY
WEST BROADWAY
EAST BROADWAY
22ND STREET
MAIN STREET
JEFFERSON STREET
THIRD STREET
SECO-D STREET
PRESTON ST
SHELBY STREET
EASTERN PARKWAY
CRITTENDEN DRIVE
LOUISVILLE AND NASHVILLE
SEVENTH STREET
HIGHWAY
TAYLOR BLVD
ILLINOIS CENTRAL
DIXIE
K. AND I. T.
ALGONQUIN PARKWAY
BELLS LANE
RALPH AVENUE
KRAMERS LANE
RUN ROAD
CRUMS LANE
CAMP GROUND ROAD
LEES LANE
CANE RUN
ROCKFORD
CITY BOUNDARY
BROWNSBORO ROAD
LEXINGTON ROAD
BARDSTOWN ROAD
NEWBURG ROAD
POPLAR LEVEL ROAD
PRESTON STREET
ROAD

FIG. F.9A.

MAP SHOWING MAXIMUM AND MINIMUM TEMPERATURES OF GROUND WATER IN THE LOUISVILLE AREA, KENTUCKY, 1945–55

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3/8"

BOTTOM OF IMAGE AREA, OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS

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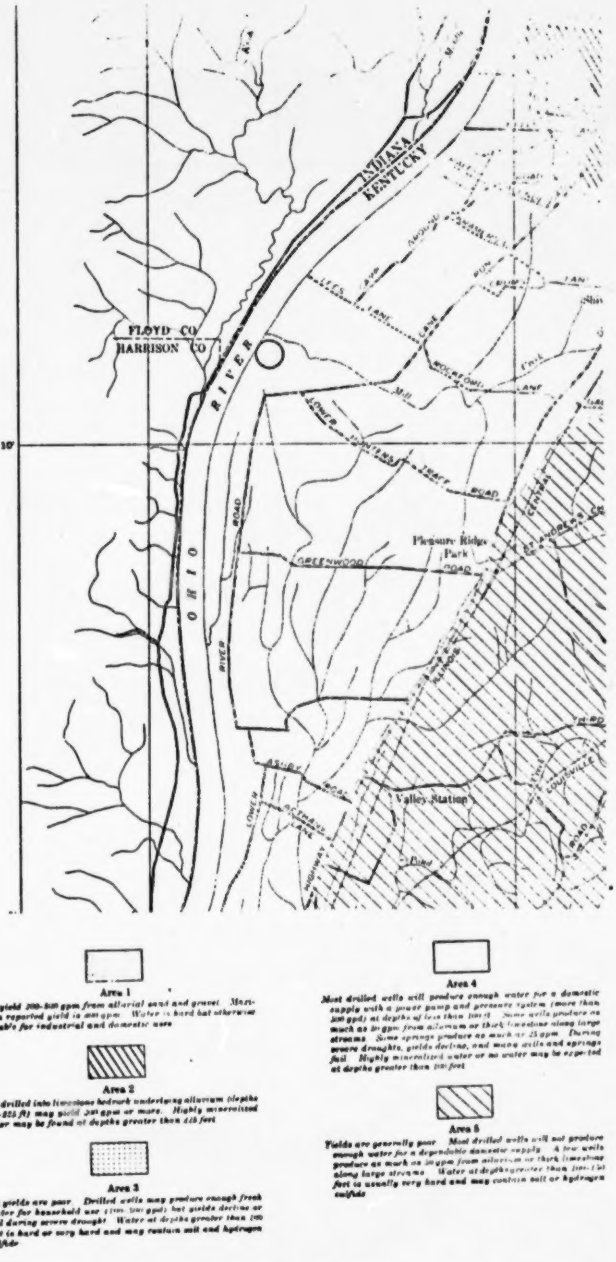
INDIANA
KENTUCKY
FLOYD CO
HARRISON CO
OHIO
RIVER
10'
LEES LANE
Mill
LOWER HUNTERS TRACE ROAD
Pleasure Ridge Park
GREENWOOD
ROAD
RIVER ROAD
DIXIE HIGHWAY
Valley Station
Pond
Area 1
Area 2
Area 3
Area 4
Area 5

Area 1
Wells yield 200-500 gpm from alluvial sand and gravel. Maximum reported yield is [illegible] gpm. Water is hard but otherwise suitable for industrial and domestic uses

Area 2
Wells drilled into limestone bedrock underlying alluvium (depths 100-225 ft) may yield 200 gpm or more. Highly mineralized water may be found at depths greater than 225 feet

Area 3
Most yields are poor. Drilled wells may produce enough fresh water for household use (100-500 gpd) but yields decline or fail during severe drought. Water at depths greater than 100 feet is hard or very hard and may contain salt and hydrogen sulfide

Area 4
Most drilled wells will produce enough water for a domestic supply with a power pump and pressure system (more than 500 gpd) at depths of less than 100 ft. Some wells produce as much as 50 gpm from alluvium or thick limestone along large streams. Some springs produce as much as 25 gpm. During severe droughts, yields decline, and many wells and springs fail. Highly mineralized water or no water may be expected at depths greater than 100 feet

Area 5
Yields are generally poor. Most drilled wells will not produce enough water for a dependable domestic supply. A few wells produce as much as 50 gpm from alluvium or thick limestone along large streams. Water at depths greater than 100-150 feet is usually very hard and may contain salt or hydrogen sulfide

FIG. F.9B. WELL YIELDS AND WATER QUALITY

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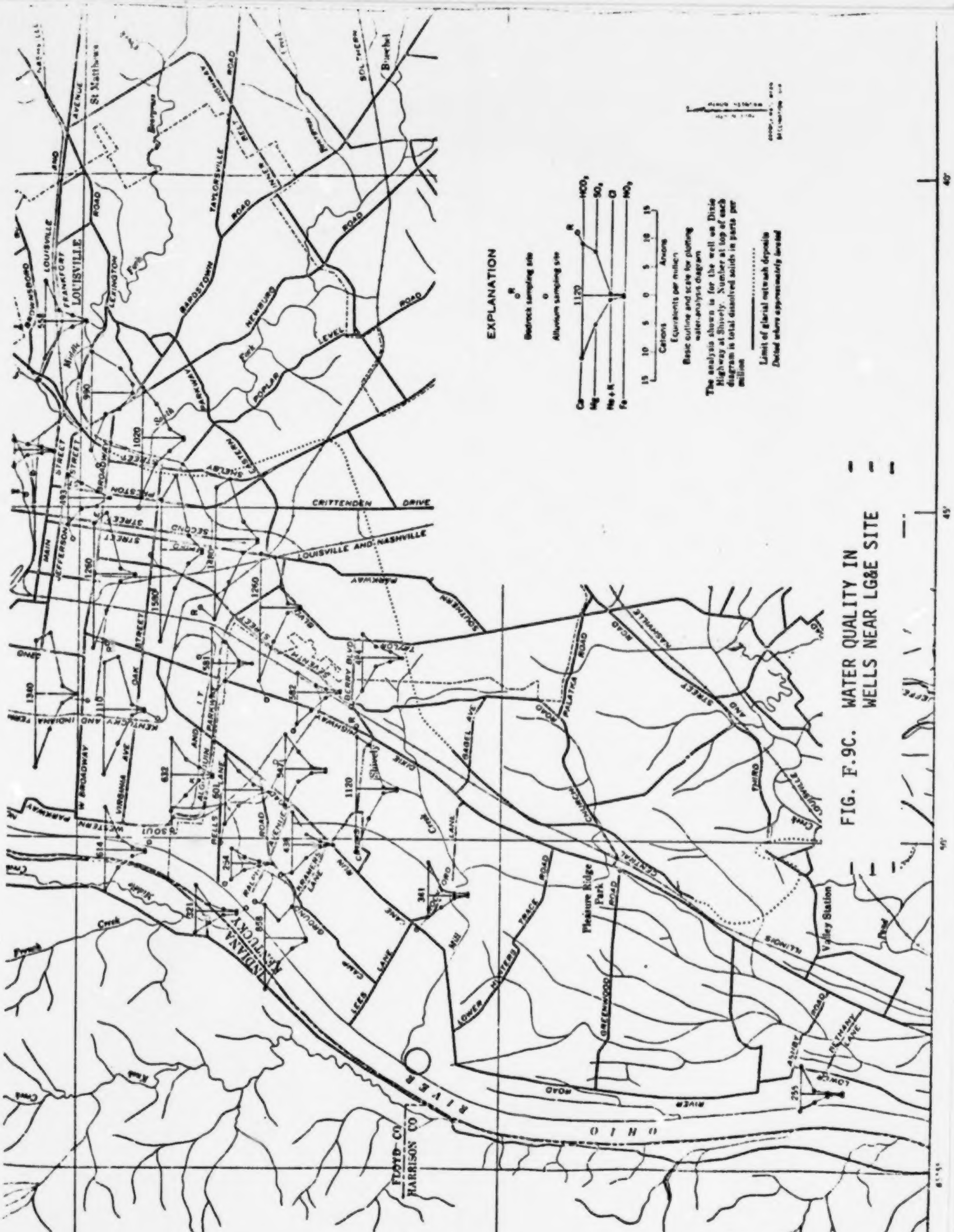
EXPLANATION
Bedrock sampling site
Alluvium sampling site
Ca
Mg
Na + K
Fe
HCO3
SO4
Cl
NO3
1120
15 10 5 0 5 10 15
Cations
Anions
Equivalents per million
Basic outline and scale for plotting water-analysis diagram
The analysis shown is for the well on Dixie Highway at Shively. Number at top of each diagram is total dissolved solids in parts per million
Limit of glacial outwash deposits
Dotted where approximately located
LOUISVILLE
St Matthews
Buechel
INDIANA
KENTUCKY
OHIO RIVER
FLOYD CO
HARRISON CO
Pleasant Ridge Park
Valley Station
Shively
CRITTENDEN DRIVE
LOUISVILLE AND NASHVILLE
TAYLORSVILLE ROAD
BARDSTOWN ROAD
NEWBURG
POPLAR LEVEL ROAD
W BROADWAY
VIRGINIA AVE
OAK STREET
DIXIE
GREENWOOD ROAD
LOWER HUNTERS TRACE
LEES LANE
MAIN
JEFFERSON
STREET
Beargrass
French Creek
1260
1580
1380
1110
1020
990
632
941
1120
614
521
658
341
234
255

FIG. F.9C. WATER QUALITY IN WELLS NEAR LG&E SITE

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materials of the aquifer were found to be dry and to be deposited in layers. This layered effect was obvious in an examination of the sides of the excavation for the flyash pit. It was very difficult to detect quantitative differences between the materials in the various layers, beyond a slight variation in the grain size of the material.

Figure F.10 shows information from wells in the area around the Louisville Gas & Electric Can Run Plant. Additionally hydrographs for wells at the plant site were shown in a previous figure as Figures F.8C, F.8E, and F.8K. The information in these figures, coupled with the on-site examination indicate that the groundwater table in the area of the plant exists at a depth of 35 to 40 feet below the existing ground surface. This groundwater table in all probability has been locally depressed by substantial pumping of water from the aquifer by the Louisville Gas & Electric Company in wells on the plant site. In any case, the groundwater elevation is significantly below the bottom elevation of any of the land disposal sites. Additionally, water flow in this area can be inferred from the information presented previously. During most of the year, the water flow in the sand and gravel aquifer beneath the Cane Run Plant would be in a direction toward the Ohio River and somewhat parallel to the river. In other words, water flows from the underlying bedrock (limestone) to the north and east of the plant site and through the aquifer and thence into the Ohio River. The water flow direction at the plant site would be approximately west by southwest. Water flow direction would be reversed and water would flow from the Ohio River into the aquifer only during periods of high water when the Ohio River was flooding.

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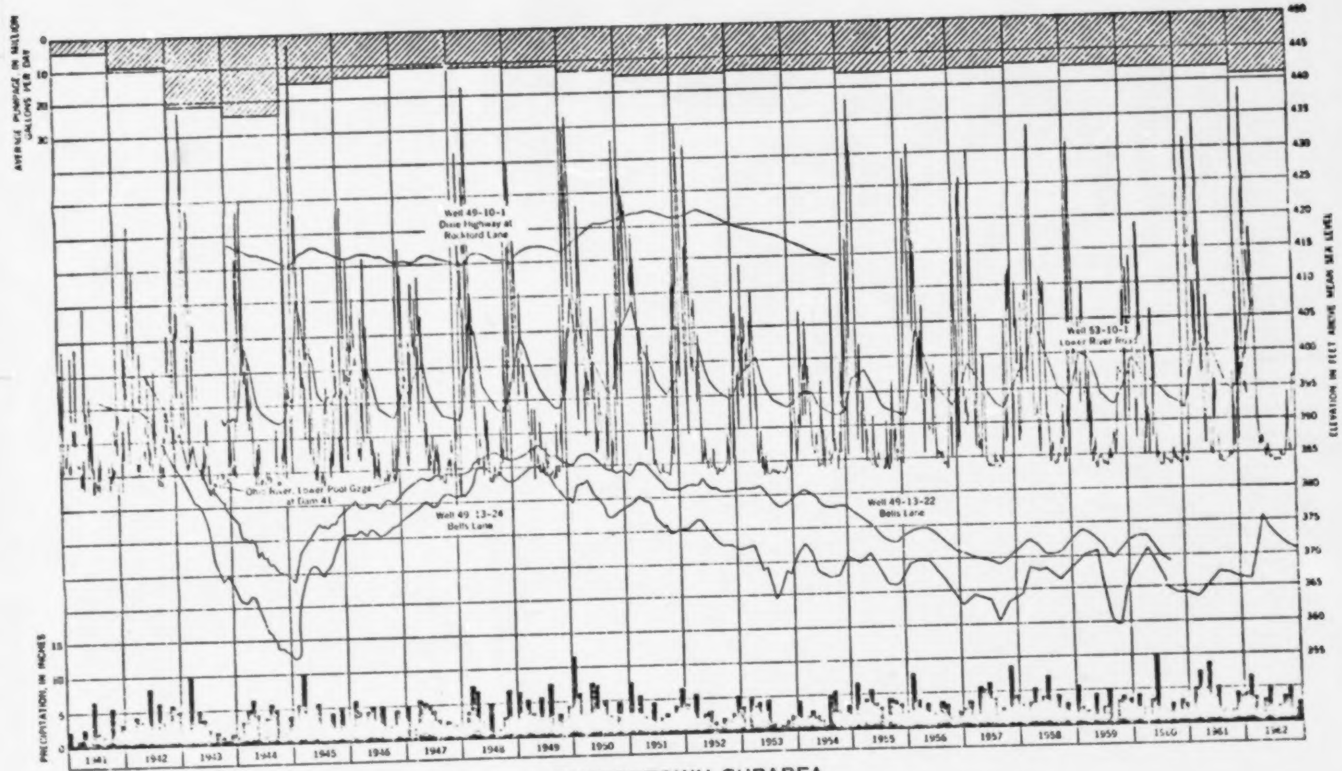

RUBBERTOWN SUBAREA

FIG. F.10. WATER LEVELS,
PUMPAGE PRECIPITATION

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